SYSTEMATIC COLLECTIONS OF THE AGRICULTURAL RESEARCH SERVICE

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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

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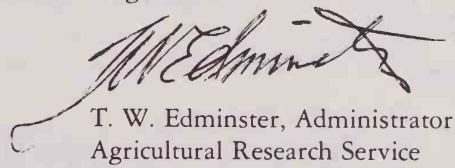
Foreword

Most agricultural and biological research depends on the information extracted from systematic collections of plants and animals. Competent systematists can derive significant data from these collections and associated resources. To assure that biosystematic data are readily available to the research programs of the Agricultural Research Service (ARS) and to other organizations, ARS supports 13 major systematic collections and 80 curators. These collections contain over 25 million specimens representing nearly 1 million species. They are recognized not only in this country but throughout the world for their contributions to taxonomic research.

It is particularly appropriate to assemble and disseminate information on the systematic collections and scientists supported by ARS on the occasion of Beltsville Symposium II, Biosystematics in Agriculture.



T. W. Edminster, Administrator
Agricultural Research Service

Contents

Page

Animal parasites 3
U.S. National Parasite Collection 3
Fungi and bacteria 7
ARS Culture Collection 7
U.S. National Fungus Collections 15
Insects 27
ARS Cotton Insect Collection 27
U.S. National Museum of Natural History Entomological Collection 29
U.S. National Pollinating Insects Collection 55
U.S. Rangeland Grasshopper Collection 59
Nematodes 61
USDA Nematode Collection 61
Plants 65
ARS Cotton Herbarium 65
Inter-Regional Potato Introduction Herbarium 67
U.S. Living Collection of Perennial Triticeae Grasses 69
U.S. National Arboretum Herbarium 73
Seeds 79
U.S. National Seed Herbarium 79
Index of active systematists 83

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SYSTEMATIC COLLECTIONS OF THE AGRICULTURAL RESEARCH SERVICE

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Detailed systematic information becomes increasingly necessary with the growing demand for more and better quality agricultural products. High quality agricultural research depends on authoritative identification and on related data such as the biology and distribution of the organism being studied. To provide the biosystematic information necessary for agriculture, the Agricultural Research Service (ARS) has developed a major resource of biological collections.

Thirteen major collections are supported by ARS. Several of them are over 100 years old and contain thousands of specimens; one has over 24 million accessions. These collections are among the most extensive in the world and have a wide influence on international biological research. Other smaller, more recent collections fill a specialized niche and are highly valued for their direct applicability to agricultural problems. The collections with their associated libraries are an invaluable resource to systematists all over the world.

The main responsibilities of ARS systematists are research, service identification, and curation of the collections. The primary function of each of these scientists is to provide accurate biosystematic research data. As an indication of the scope and quality of this research, notable accomplishments and selected publications are included as part of this report.

The ARS systematists identify about 500,000 specimens each year. They are submitted in lots, which vary from one to a group of specimens representing one or several species. These identifications support the programs or needs of ARS, other Federal, State, and international agencies, and taxpayers. Curators accession hundreds of thousands of species each year, reflecting the ever-increasing needs of ARS to learn more about beneficial, harmful, and endangered taxa.

The purpose of this report is to give the location, size, history, and significance of the 13 major ARS-supported collections.

[1] This committee prepared this publication to coincide with Beltsville Symposium II, Biosystematics in Agriculture, held at the Beltsville Agricultural Research Center, Beltsville, Md., May 8-11, 1977.

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ANIMAL PARASITES

U.S. NATIONAL PARASITE COLLECTION

Parasite Classification and Distribution Unit
Animal Parasitology Institute

By J. RALPH LICHTENFELS

Location: Bldg. 1180, BARC–East, Beltsville, Md. 20705
Loans: To recognized scientists and institutions
Associated libraries: 4,000 volumes, 52,000 reprints
Number of accessions: 70,000 lots
Types: 10,000 lots
Curator: J. Ralph Lichtenfels, (301)–344–2444

Background

The U.S. National Parasite Collection, the world's largest collection of parasites of animals and man, is the major type repository for North American parasitologists and for others who lack adequate facilities (figs. 1 and 2).

The collection was started in 1892 by USDA scientists Charles Wardell Stiles and Albert Hassall with their personal collections as the nucleus. It was initially called the BAI Collection (Bureau of Animal Industry). In 1894 the Smithsonian Institution authorized Stiles to establish a U.S. National Museum Helminthological Collection to be maintained by the Department of Agriculture as a research tool. This arrangement still exists. In addition to the designations BAI Collection and USNM Helminthological Collection, other names previously used include Zoological Division Parasite Collection, USDA Parasite Collection, Beltsville Parasite Collection, and the Animal Parasite Collection. Since 1969 the name U.S. National Parasite Collection has been used and specimens have been accessioned either in the USNM Helminthological Collection (all types and most specimens documented in the literature) or in the USDA Parasite Collection. Because separate collections have not been established for many other groups of parasites of animals, the USNM Helminthological Collection has many kinds of parasites other than helminths. They include protozoa, arthropods, and miscellaneous phyla.

In addition to Stiles and Hassall, the collection has been curated by B. H. Ransom, M. C. Hall, A. McIntosh, W. W. Becklund, and M. B. Chitwood. Other USDA workers associated with the collection over the years include B. G. Chitwood, E. B. Cram, G. Dikmans, J. T. Lucker, E. W. Price, and E. E. Wehr.

PN-5469

FIGURE 1.—ARS curator examining 1 of more than 50,000 bottles of animal parasites.

PN-5470

FIGURE 2.—A display of animal parasites.

Major personal collections contributed to the U.S. National Parasite Collection include those of E. Linton, H. B. Ward, G. A. MacCallum, G. R. LaRue, A. O. Foster, R. E. Kuntz, D. C. Kritsky, and J. H. Fischthal.

All specimens in the U.S. National Parasite Collection are indexed by parasite name, host name, and accession number. About 800 to 1,000 lots are added annually. A checklist of primary types in the collection is being prepared (U.S. Department of Agriculture, "Index-Catalogue of Medical and Veterinary Zoology," Special Publication No. 4).

Service Identification

A limited identification service is provided, with priority given to parasites of veterinary or medical importance. Emphasis is placed on the preparation of illustrated keys and manuals, which permit many parasitologists to identify their own specimens.

Research

Research objectives include the discovery and evaluation of systematic characters useful for identifying and classifying parasites of veterinary and medical importance. Parasites are exposed to various environmental stresses, such as an immune host or a different species of host, to determine whether observed variations in systematic characters are caused by the environment or are inherent in the parasite. Detailed morphological studies of larval and adult parasites are carried out to permit the identification of parasites in tissue sections and to predict possible infectivity of larval forms from their classification. Emphasis is placed on the preparation of keys to major groups of parasites.

Selected Achievements

1911 Published illustrated keys to nematode parasites of ruminants

1916 Monographed nematode parasites of small mammals

1927 Monographed nematode parasites of birds

1945 Published and later revised (1964) "Check List of Internal and External Parasites of Domestic Animals in United States, Its Possessions, and Canada," including data on distribution

1960 Identified exotic African red tick (*Rhipicephalus evertsi*), enabling eradication within relatively short period of a known vector of several important diseases of livestock

1961 Identified rat lungworm (*Angiostrongylus cantonensis*) from brain of man, resulting in discovery that a nematode is causative agent of parasitic or eosinophilic meningoencephalitis in the South Pacific

1970 Published checklist of internal and external parasites of deer in North America

1971 Published descriptions and keys to many common nematode parasites of ruminants

1971 Discovered larvae of eyeworm (*Thelazia gulosa*) in face fly (*Musca autumnalis*), the first natural vector for eyeworm of cattle in eastern North America

1973 Published first manual for identification of parasites in tissue sections, including 249 figures of parasites in lesions

1975 Published illustrated keys to helminths of domestic equids, providing necessary working tool for renewed research on parasites of horses

Selected Publications

Becklund, W. W. 1964. Revised check list of internal and external parasites of domestic animals in the United States and possessions and in Canada. Amer. Jour. Vet. Res. 25: 1380–1416.

Becklund, W. W. 1968. Ticks of veterinary significance found on imports in the United States. Jour. Parasitol. 54 (3): 622–628.

Becklund, W. W., and Walker, M. L. 1967. *Nematodirus* of domestic sheep, *Ovis aries*, in the United States with a key to the species. Jour. Parasitol. 53 (4): 777–781.

Becklund, W. W., and Walker, M. L. 1968. *Ostertagia dikmansi* sp. n. (Nematoda:Trichostrongylidae) from deer, *Odocoileus virginianus*, with a key to the species of medium stomach worms of *Odocoileus* in North America. Jour. Parasitol. 54 (3): 441–444.

Becklund, W. W., and Walker, M. L. 1969. Taxonomy, hosts, and geographic distribution of the *Setaria* (Nematoda:Filarioidea) in the United States and Canada. Jour. Parasitol. 55 (2): 359–368.

Chitwood, M. B. 1970. Comparative relationships of some parasites of man and old and new world subhuman primates. Lab. Anim. Care 20 (2): 389–394.

Chitwood, M. B. 1970. Nematodes of medical significance found in market fish. Amer. Jour. Trop. Med. and Hyg. 19 (4): 599–602.

Chitwood, M. B., and Lichtenfels, J. R. 1972. Identification of parasitic metazoa in tissue sections. Expt. Parasitol. 32: 407–519.

Chitwood, M. B., and Stoffolano, J. G. 1971. First report of *Thelazia* sp. (Nematoda) in the face fly, *Musca autumnalis*, in North America. Jour. Parasitol. 57 (6): 1363–1364.

Lichtenfels, J. R. 1971. Morphological variation in the gullet nematode, *Gongylonema pulchrum* Molin, 1857, from eight species of definitive hosts with a consideration of *Gongylonema* from *Macaca* spp. Jour. Parasitol. 57 (2): 348–355.

Lichtenfels, J. R. 1975. Helminths of domestic equids. Illustrated keys to genera and species with emphasis on North American forms. Helminthol. Soc. Wash. Proc. 42: 1–92 (spec. issue).

Lichtenfels, J. R., and Brancato, F. P. 1976. Anisakid larva from the throat of an Alaskan Eskimo. Amer. Jour. Trop. Med. and Hyg. 25 (5): 691–693.

McIntosh, A. 1932. Description of a tick, *Dermacentor halli* from the Texas peccary, with a key to the North American species of *Dermacentor*. U.S. Natl. Mus. Proc. 82: 1–6.

McIntosh, A., and McDuffie, W. C. 1956. Ticks that affect domestic animals and poultry. *In* Animal Diseases, U.S. Dept. Agr. Ybk. 1956: 157–166.

Ransom, B. H. 1911. The nematodes parasitic in the alimentary tract of cattle, sheep, and other ruminants. U.S. Dept. Agr., Bur. Anim. Indus. Bul. 127, 132 pp.

Walker, M. L., and Becklund, W. W. 1970. Checklist of the internal and external parasites of deer, *Odocoileus hemionus* and *O. virginianus*, in the United States and Canada. U.S. Dept. Agr. Index-Cat. Med. and Vet. Zool., Spec. Pub. No. 1, 45 pp.

FUNGI AND BACTERIA

ARS CULTURE COLLECTION

Fermentation Laboratory
Northern Regional Research Center

By THOMAS G. PRIDHAM

Location: Northern Regional Research Center, Peoria, Ill. 61604

Loans: None; progenies of living strains provided free of charge to bona fide requesters

Associated libraries: 10,000 volumes, 620 journals, access to data bases of Lockheed Dialog System

Number of accessions: 55,000 strains, 465 genera

Types: Many of various kinds

Curators: Thomas G. Pridham (curator-in-charge), (309)-685-4011, ext. 304, or FTS 360-4304
General microbiology; systematics, microbiology, and antibiotics of Actinomycetales; microbiological aspects of patents; culture collection technology and administration

John J. Ellis, (309)-685-4011, ext. 266, or FTS 360-4266
Systematics of molds, especially Mucorales

Dorothy I. Fennell, (309)-685-4011, ext. 267, or FTS 360-4267
Systematics of *Aspergillus* and *Penicillium;* metabolic products of *Aspergillus, Penicillium,* and related genera; culture collection maintenance

Cletus P. Kurtzman, (309)-685-4011, ext. 303, or FTS 360-4303
Systematics of yeasts—morphology, ultrastructure, genetics, and nucleic acids

Lawrence K. Nakamura, (309)-685-4011, ext. 258, or FTS 360-4258
General microbiology; microbial physiology; microbial fermentations; bacterial systematics

Background

The ARS Culture Collection is probably the world's largest collection of living strains of agriculturally and industrially important micro-organisms. Its staff provides research materials, conducts microbiological research, and identifies bacteria, yeasts, molds, and Actinomycetales. The collection is

preserved almost entirely in freeze-dried form to provide stable viable microbial germ plasm. The availability of diverse strains and of experts familiar with the systematic relationships, biochemical behavior, and requirements for culturing and maintaining these strains has contributed to many significant accomplishments of the Northern Regional Research Center.

The collection had a trifurcate origin. One line goes back to 1904, when Charles Thom (1872–1956) was assigned by the U.S. Department of Agriculture to investigate the microbiology of Roquefort and Camembert cheeses in the Connecticut Experiment Station at Storrs. In 1913, he moved to Washington, D.C., and took cultures of his strains with him. He augmented his collection of mostly Aspergilli and Penicillia with further isolations and the acquisition of additional strains. The Thom collection was later called the Thom and Church collection, in recognition of the contributions of Margaret B. Church, Thom's assistant. It was the source of many of the molds initially distributed by the American Type Culture Collection, Rockville, Md.

Kenneth B. Raper became Thom's associate in 1929. He headed the Culture Collection Section of the Fermentation Division of USDA's Northern Regional Research Laboratory (NRRL), now known as the Northern Regional Research Center, when NRRL operations began in 1940 in Peoria. He selected about 1,200 of the Thom and Church mold strains to be the nucleus of the NRRL Culture Collection, now the ARS Culture Collection.

The second line of descent of the collection also had its roots in Thom's work. As a result of his discoveries with J. N. Currie, fermentative production of citric acid had become a successful commercial venture. To exploit this newly developing field, investigators in the U.S. Department of Agriculture's Color Laboratory (officially the Division of Color and Farm Wastes) at the Arlington Experimental Farm in Virginia, with Thom's collaboration, began a study of microbial fermentations. Eventually the task of maintaining a variety of strains involved in this work was assigned to Andrew J. Moyer, who was succeeded by Lewis B. Lockwood. In 1940, when both Moyer and Lockwood became members of the new Fermentation Division, Lockwood took the Arlington Farm cultures to NRRL, where the fungi were incorporated in the mold collection and the bacteria became the nucleus of the bacterial collection. To augment these original holdings, Raper and his associates collected industrially important and taxonomically significant strains. The collection of molds in the ARS Culture Collection now is curated by John J. Ellis and Dorothy I. Fennell.

The third line of descent dates from 1935, when Lynferd J. Wickerham began a collection of yeasts at Michigan State College (now Michigan State University) and added to it later while studying at Yale University and while teaching at the University of Illinois. In 1950, Wickerham developed both yeast and bacterial collections in the newly established ARS Culture Collection Section at NRRL. Within a short time, it became necessary to divide responsibility for the two collections under his care. On Wickerham's retirement in 1970, he was succeeded by Cletus P. Kurtzman.

In 1941, William C. Haynes became curator of the bacterial collection until he was called to active military duty. Robert G. Benedict succeeded him as curator

for several years. During his tenure, numerous bacterial strains were acquired for an antibiotic and growth factor screening program. Haynes returned and curated the bacterial collection until his retirement in 1975, when he was succeeded by Lawrence K. Nakamura.

In 1953, Raper, who had gone to the University of Wisconsin, was succeeded by Clifford W. Hesseltine as head of the ARS Culture Collection. Hesseltine brought with him a large collection of Mucorales. He also had an interest in antibiotic-producing streptomycetes and began isolating these micro-organisms from soil samples. In the same year, Thomas G. Pridham succeeded Benedict in the screening program. Pridham had been working with streptomycetes since 1945 at the University of Illinois and had been collaborating since 1948 with Benedict in identifying antibiotic-producing strains. He began to combine the several individual collections of Actinomycetales and to augment the collection.

In 1967, because of the increasing number of Actinomycetales and the many strains deposited in connection with patent applications, two additional collections were established—the Actinomycetales and the patent collection—with Pridham as curator of both. In 1969, when Hesseltine became chief of the Fermentation Laboratory, Pridham succeeded him as head of the ARS Culture Collection.

At the University of Illinois, Wickerham had become interested in a new lyophilization or freeze-drying technique for preserving micro-organisms and had devised an inexpensive apparatus (fig. 1) and a simple, rapid method of

FIGURE 1.—Technician completing lyophile process. PN-5471

lyophilizing his yeast cultures. When he came to NRRC, he introduced this technique to the Culture Collection Section, where it was applied to all categories of micro-organisms in the collection. The ARS Culture Collection was the first to adopt lyophilization as a routine technique for preserving diverse micro-organisms in a viable state.

The ARS Culture Collection has grown in the number of strains of micro-organisms maintained. The initial few thousand molds and yeasts and few hundred bacteria have increased to about 28,000 strains of molds, 13,000 strains of yeasts, 8,300 strains of bacteria, and 6,500 strains of Actinomycetales. Several thousand new strains are acquired each year.

Most of the strains in the collection have been donated by investigators from all over the world and by various curators from their isolation work. Many strains have come from other culture collections, and the ARS Culture Collection has an agreement whereby strains are exchanged free of charge.

A small, but important group of accessions consists of strains of molds, yeasts, bacteria, and Actinomycetales deposited to satisfy requirements of the U.S. Patent and Trademark Office in connection with applications for U.S. patents. The ARS Culture Collection is one of two in the United States recognized by this office as suitable for this function.

Service Identification

A variety of services is provided to the public and to researchers in industry, academe, and government, both nationally and internationally. They include identifying bacteria, Actinomycetales, yeasts, and molds; distributing progenies of strains of micro-organisms; maintaining progenies of strains of micro-organisms, which are the subjects of patents; providing information on many microbiological subjects; and conducting supportive microbiological research for *in house* and *extramural* programs on a variety of research projects, e.g., mycotoxins, cereal microbiology, animal waste handling, fermented food, photosynthesis, and nitrogen fixation.

Research

Exploitation of the fermentative abilities of micro-organisms in the utilization of excess farm commodities was the original expressed purpose of NRRC's Fermentation Division. Consequently, the ARS Culture Collection always has been deeply involved in microbiological research other than the traditional systematics and technology associated with culture collection operations. The reasons for exploitation of micro-organisms have changed, but the deep involvement in microbiological research continues.

In recent years, the collection has become part of a larger unit within the Fermentation Laboratory known as ARS Culture Collection Research. Pridham is research leader of this unit. Activities associated with the collection have thereby been extended to include studies on the microbiology of flour, cereals, oilseeds, fermented food products, mycotoxins, microbial insecticides, and residue utilization. The expanded activity has led to a larger staff, which includes 10 professional microbiologists and biochemists and 8 technical aides.

Present research efforts by curators of the ARS Culture Collection include systematics of *Rhizobium,* Actinomycetales, *Pichia, Saccharomycopsis, Aspergillus, Penicillium,* Mucorales, and related genera; microbiology of swine waste-corn fermentations; enumeration of Actinomycetales; DNA/DNA hybridization in yeasts; mycology of preharvest and postharvest contamination of grains, particularly maize, with toxic metabolites of Aspergilli and Penicillia; and replication and transmission of viruslike particles in species of *Penicillium.*

Future research plans include studies of enterobacteria in swine waste and swine waste-corn fermentations; guanine + cytosine determinations of nucleic acids and nucleic acid homologies in *Rhizobium,* Actinomycetales, yeasts, *Aspergillus,* and *Penicillium;* description of new species of *Pichia* and *Saccharomycopsis;* mycological aspects of mycotoxin and mycovirus research; a monographic treatment of genera of Mucorales; and microbial production of cellulase.

Selected Achievements

1942 Developed rapid lyophilization process and applied it to preserving and maintaining diverse micro-organisms
1943 Isolated improved penicillin-producing strains of *Penicillium chrysogenum*
1945 Prepared authoritative manual on *Aspergillus* (revised 1965)
1946 Discovered riboflavin production by *Ashbya gossypii*
1949 Prepared authoritative manual on *Penicillium*
1950 Developed Symba amylase process, using yeasts to degrade starch
1954 Discovered dextran production by *Leuconostoc mesenteroides*
1957 Discovered β-carotene production by Choanephoraceae
1961 Hypothesized relationship between phosphomannan production and yeast taxonomy
1962 Developed pure culture fermentation for miso production
1966 Developed method for producing spores of *Bacillus popilliae* in liquid medium
1970 Discovered sexual stage of *Candida lipolytica*
1972 Contributed chapters on Eurotiales and Mucorales to an authoritative review of fungal genera
1973 Coauthored monograph on genus *Bacillus*
1974 Prepared authoritative treatment on Streptomycetaceae

Selected Publications

Benjamin, C. R., Haynes, W. C., and Hesseltine, C. W. 1964. Microorganisms. What they are, where they grow, what they do. U.S. Dept. Agr. Misc. Pub. 995, 36 pp.

Burton, K. A., Nakamura, L. K., and Cadmus, M. C. 1976. Identification of polysaccharide-producing black yeasts. Mycologia 68: 685–688.

Ellis, J. J. 1963. A study of *Rhopalomyces elegans* in pure culture. Mycologia 55: 183–198.

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Haynes, W. C., Wickerham, L. J., and Hesseltine, C. W. 1955. Maintenance of cultures of industrially important microorganisms. Appl. Microbiol. 3: 361–368.

Hesseltine, C. W. 1965. A millennium of fungi, food and fermentation. Mycologia 57: 149–197.

Hesseltine, C. W. 1972. Solid state fermentations. Biotechnol. and Bioengin. 14: 517–532.

Hesseltine, C. W., and Anderson, R. F. 1957. Microbiological production of carotenoids. I. Zygospores and carotene produced by intraspecific and interspecific crosses of *Choanephoraceae* in liquid media. Mycologia 49: 449–452.

Hesseltine, C. W., and Haynes, W. C. 1973. Sources and management of microorganisms for the development of a fermentation industry. Prog. Indus. Microbiol. 12: 1–46; U.S. Dept. Agr. Agr. Handb. 440, 38 pp. (1974).

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U.S. NATIONAL FUNGUS COLLECTIONS

Mycology Laboratory
Plant Protection Institute

By PAUL L. LENTZ

Location: Third floor, Bioscience Bldg., BARC–West, Beltsville, Md. 20705
Loans: To recognized institutions and scientists
Associated libraries: 5,600 volumes; 50,000 pamphlets and reprints
Number of accessions: 800,000 collections; 100,000 taxa, including species and varieties
Types: 25,000
Curators: Paul L. Lentz, curator-in-charge, (301)344–3365
Basidiomycetes, Aphyllophorales, phytopathogens, and micromorphology
Lekh R. Batra, (301)–344–3366
Hemiascomycetes, Plectomycetes, Discomycetes, Sclerotiniaceae, phytopathogens, and insect-fungus relationships
David F. Farr, (301)–344–3365
Aquatic Phycomycetes, Basidiomycetes, and Agaricales
Marie L. Farr, (301)–344–3366
Myxomycetes, Pyrenomycetes, and black mildews
Kent H. McKnight, (301)–344–3169
Basidiomycetes, Agaricales, Boletales, Gasteromycetes, Discomycetes, and Pezizales
Flora G. Pollack, (301)–344–3364, (Animal and Plant Health Inspection Service)
Deuteromycetes and phytopathogens
Francis A. Uecker, (301)–344–3364
Pyrenomycetes, cytology, and developmental morphology

Background

The U.S. National Fungus Collections is a mycological institution that includes the world's largest herbarium of fungus specimens, together with technical reference literature and data files. It is a base for research and service in national and international mycology and plant pathology.

Fungus collections of the Smithsonian Institution were transferred to the U.S. Department of Agriculture in 1869 as the foundation of the Pathological Collections. Later they became the Mycological Collections and finally the

National Fungus Collections, as changes in the title reflected a broadened role and status of the technical resources.

The fungus herbarium was first a component of the Division of Botany in the Department of Agriculture, then in the Section of Vegetable Pathology, and later in the Division of Vegetable Physiology and Pathology. In 1885, when the herbarium had fewer than 3,000 collections, F. Lamson Scribner assumed charge as the first Federal pathologist. He was followed by Franklin S. Earle in 1891 and by Flora W. Patterson in 1896. Patterson organized programs and assembled a staff that notably influenced subsequent development of the National Fungus Collections. Emphasis was on the taxonomy of plant pathogens, with recognition also that significant pathogens and closely related potential pathogens appear in nearly every fungus family.

Departmental programs of research on diseases of commercial mushrooms, plant quarantine taxonomy, and plant disease survey were developed to their full level of effectiveness while integrated with the U.S. National Fungus Collections. This was during the period from Patterson's regime until World War II or later.

The presence in America of the bubbles disease of mushrooms, which threatened the entire industry, was first recognized in 1909 by scientists in the U.S. National Fungus Collections. Control studies were made by Frank J. Veihmeyer. Earliest American investigations of "plaster molds" and other important pathogens of mushrooms also were accomplished within this organization. After 1903, much of this research was done by Vera K. Charles, who also was associated with Patterson in the production of the only comprehensive mushroom identification manual ever prepared by the U.S. Government. Edmund B. Lambert later had responsibility for research on commercial mushrooms.

Before the Plant Quarantine Act was passed in 1912, Charles and Patterson also conducted pathological inspection of imported plants. Among their interceptions was the dangerous potato wart disease caused by *Synchytrium endobioticum,* which they identified for the first time in the United States on imported potatoes.

In 1917, the Plant Disease Survey was organized as a distinct project coordinate with the Pathological Collections. Cooperation between these units stimulated progress on a taxonomic and host-distribution inventory of American pathogens, as documented by specimens in the National Fungus Collections.

At first, nearly all research and service activities of the Pathological Collections were the personal responsibility of Patterson and Charles. In addition to her studies of mushrooms, Charles did research on the fungal pathogens of insects. In 1941, this work culminated in the publication of a comprehensive checklist of entomogenous fungi of North America. In 1912, the scientific staff was enlarged by the appointment of Anna E. Jenkins, in 1913 by Edith K. Cash, and in 1917 by William W. Diehl. Each became well known for mycological research in association with the National Fungus Collections. Jenkins was the foremost authority on spot-anthracnose fungi, which cause leaf

and blossom diseases and scab of many economic plants. The representation of these fungi in the National Fungus Collections is the most comprehensive and taxonomically authoritative anywhere. Cash was widely recognized for her investigation of cup fungi (discomycetes), which also include major plant pathogens. Diehl's work culminated in the publication of the only modern monograph on *Balansia,* a genus of pathogens significant in causing sterility in grasses.

Patterson retired in 1923 and James R. Weir was in charge of the National Fungus Collections until 1927. Weir eventually became associated with ventures for rubber cultivation in South America and Malaya. While in charge of the National Fungus Collections, he prepared a comprehensive report on the fungi that cause diseases of the *Hevea* rubber tree. When Patterson retired, Cornelius L. Shear was given administrative responsibility for the combined unit in which the National Fungus Collections was associated with the Plant Disease Survey. In 1927, Shear collaborated with B. O. Dodge in the publication of a pioneering report on the life histories and heterothallism of red bread-mold fungi. This was the study that later brought *Neurospora* into prominence as an experimental genetic organism and opened up a broad new field of genetic research.

When the Pathological Collections was initiated, emphasis was on the accretion of specimens, particularly those that represented research findings, type and authentic specimens, disease specimens, and well-documented specimens in sets of fungi exsiccati. After 1927, when John A. Stevenson succeeded Weir in charge of the collections, buildup of the herbarium and associated reference material was intensified. Stevenson had worked in Puerto Rico as a plant pathologist. He retained his interest in tropical pathology while in charge of the Mycological Collections. As a result, he collaborated extensively with tropical plant pathologists, such as F. D. Wellman, in development of the herbarium, specimen identification, preparation of geographical and host compendia, and research publications. Working relationships also were developed with outstanding national authorities, such as J. L. Lowe and G. B. Cummins, specialists in the taxonomy of wood-decay polypores and rust fungi, respectively. Ross W. Davidson was employed in 1928 in the National Fungus Collections. After a few years, his transfer to the Office of Forest Pathology stimulated further cooperation with that organization in the acquisition of wood-decay fungi as herbarium specimens.

Paul L. Lentz joined the professional staff in 1947. His interests in the classification and biology of wood-decay fungi resulted in a monograph on *Stereum* in 1955 and led then to the recognition and description of the fungus that causes pecky cypress. In 1958, Marie L. Farr came to the National Fungus Collections as a taxonomic specialist in the myxomycetes. She has worked extensively also with black mildews and other fungi prevalent in the Tropics as leaf parasites, epiphytes, and hyperparasites. Chester R. Benjamin was placed in charge of the National Fungus Collections as Stevenson's successor in 1960. Within a few years, he was able to increase the staff with additional mycologists. John L. Cunningham, a specialist in rust taxonomy, arrived in

1965, as did Francis A. Uecker, whose specialization is in the cytology and developmental morphology of pyrenomycetes. Kent H. McKnight reestablished a program of mushroom taxonomy and ecology in 1966. The following year, Lekh R. Batra was employed to continue his diverse research projects in the classification of discomycetes, hemiascomycetes, and fungus-insect relationships. After Benjamin's departure in 1971, Lentz assumed charge of the National Fungus Collections and its associated research. Joseph F. Ammirati was employed in 1973 as an agaricologist, and he was succeeded by David F. Farr, who joined the mycology staff in 1974 to work primarily with noncultivated mushrooms.

Among the original or early acquisitions of the Pathological Collections, exsiccati from J. B. Ellis, G. L. Rabenhorst, and H. W. Ravenel are notable. Other early collections are from T. J. Burrill, G. W. Clinton, B. D. Halsted, E. W. D. Holway, M. E. Jones, W. A. Kellerman, and A. B. Langlois. Specimens were submitted from the U.S. Exploring Expedition under Commodore Wilkes, 1838–42, and also from the U.S. North Pacific Exploring Expedition under Commanders Ringgold and Rogers, 1853–56. The earliest American collections of fungi were those by L. D. von Schweinitz. Many of the Schweinitz collections and those by M. A. Curtis and other early American mycologists are in the National Fungus Collections. Thousands of collections also were contributed by mycologists and plant pathologists of the Department of Agriculture. Some of the most extensive are from G. G. Hedgcock, Jenkins, Shear, Stevenson, and Weir.

In 1924, the valuable G. Bresadola herbarium from Italy was purchased for the National Fungus Collections, and the E. A. Rau herbarium, including types, was acquired as a gift. The C. G. Lloyd herbarium was obtained in 1927. With more than 59,000 collections, it may be the largest fungus herbarium ever assembled by one person. Weir's herbarium of wood-decay fungi, acquired in 1928, also numbered many thousands of collections.

Other major acquisitions include the P. C. Standley collection from Honduras and Costa Rica, L. W. Nuttall fungi from West Virginia, remainders of the J. B. Ellis herbarium, the Sbarbaro collections from Europe, New York and Colorado collections by Shear, collections by E. A. Burt, specimens from the former Division of Cereal Crops and Diseases and those contributed by the Horticultural Crops and Diseases Division (USDA), the herbarium of R. Ciferri from the Dominican Republic, O. A. Reinking's Philippine collections, the G. L. Zundel smut herbarium, E. R. Bethel's herbarium of Colorado fungi, the W. H. Long collections of rust fungi and gasteromycetes, C. E. Chardon's herbarium of parasitic fungi from the West Indies and Central and South America, Japanese fungi from N. Hiratsuka, type specimens of P. A. Karsten's European wood-decay fungi, remainders of the Chinese National Herbarium, the J. H. Faull rust fungi, Elizabeth B. Morse's mushrooms, E. F. Guba's collections of *Pestalotia,* and the entire mycological herbaria of Goucher College, Stanford University, the Missouri Botanical Garden, and the Brooklyn Botanic Garden, including the large personal herbarium of F. Bubak and the collections of D. Griffiths and G. M. Reed.

In 1953, the fungus herbarium of the New Haven, Conn., Forest Service field station was transferred to the National Fungus Collections. A recent acquisition is the herbarium of the Connecticut Agricultural Experiment Station at New Haven. It includes the smut fungi of G. P. Clinton. Another recent addition is the myxomycete herbarium of T. H. Macbride and G. W. Martin from the State University of Iowa. As a result of this acquisition, the myxomycete section in the National Fungus Collections is now among the most notable in the world. The same is true of the polypore and rust collections, as well as several other outstanding sections of the herbarium. Collections also have been received from such well-known scientists as J. P. Anderson, R. K. Beattie, W. W. Calkins, G. W. Carver, F. S. Earle, F. D. Fromme, F. D. Hall, J. R. Hansbrough, A. G. Johnson, C. L. Lefebvre, W. H. Long, W. A. Orton, J. Rick, A. B. Seymour, E. F. Smith, F. L. Stevens, N. E. Stevens, W. T. Swingle, B. C. Tharp, S. M. Tracy, M. B. Waite, H. J. Webber, F. H. Wellman, F. A. Wolf, and many others. S. Ahmad in Pakistan and K. S. Thind in India have contributed numerous collections. Also, a policy was established by Patterson and followed by her successors for the acquisition of all sets of fungi exsiccati as they became available by purchase or exchange.

As the herbarium grew, a reference literature collection and extensive data files were developed. In recent years, the library has been built up principally as the personal collection of Stevenson, who donated it to the Smithsonian Institution. In 1976, an understanding between the Smithsonian Institution and the Agricultural Research Service provided for permanent maintenance by the research staff of the National Fungus Collections. Technical indexes also serve as sources of reference information in the National Fungus Collections. These include the New Taxa Index, with 200,000 entries; the Plant Pathogens Index, which consists of 1,200,000 cards; a herbarium fungus and host index of 200,000 records; and an index of type specimens.

Service Identification

The specimens in the National Fungus Collections have been assembled from every major area of the world. They are used often for direct comparison with suspected pathogens. In the decade starting in 1937, a yearly average of 24 packages of specimen loans from the collections was sent to mycologists for use in taxonomic research and in the preparation of monographs. The number of loans increased in each of the following decades and averaged 72 annually during 1967–77. Approximately 100,000 collections have been loaned for research study since the 1930's. These have resulted in about 1,000 research publications.

Records for a recent typical year show that services by the staff of the National Fungus Collections included assistance with fungal nomenclature and synonymy, fungal identification, herbarium specimen data, records of distribution and pathogenicity, information on mold prevention, information on mushroom poisoning and the eradication of mushrooms, and identification of poisonous mushrooms. Services were recorded for such individuals as mycologists, plant pathologists, extension pathologists, and physicians as well

as the lay public, and for institutions, including experiment stations, universities, biology publishing firms, research laboratories, government offices, museums, and hospitals.

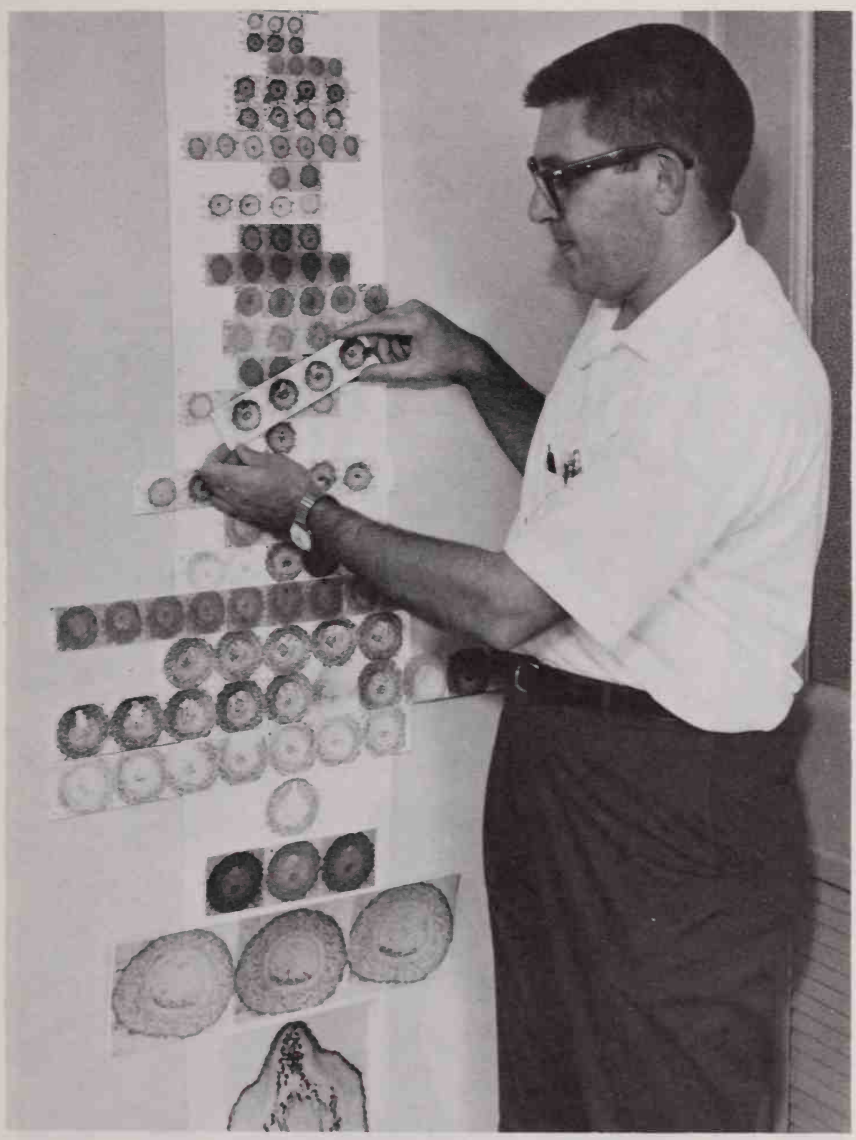
The facilities, program, and staff of the National Fungus Collections are particularly strong for dealing expertly with mycological problems of foreign origin. The herbarium and major data files have been built up with strong emphasis on foreign material. Many compendia on foreign pathogens have been produced by use of these data. Foreign projects such as the PL 480 program and Flora Neotropica are supported by technical resources of the National Fungus Collections. Support also is given to the quarantine program of the Animal and Plant Health Inspection Service. As international travel and commodity shipments increase, continuing development of technical information on the mycology of foreign countries is necessary for plant protection in the United States.

Research

The National Fungus Collections is a base for mycological research, principally research in the taxonomy of plant pathogens. In one of the major research projects, the brown rot pathogens of such fruits as apples, peaches, pears, and plums are under study. Immediate objectives are the preparation of a monograph on *Monilinia* and determination of the role of infraspecific biotypes as a cause of brown rot. A goal of this project is the establishment of standard fungal strains that can be used for testing host resistance. Other major projects include investigations of leaf, stem, and root pathogens. Recent attention has been given to the life histories and cytology of pyrenomycete pathogens of asparagus roots and Stokes aster. The life history and cytological studies are part of a series correlated with investigations in the classification of pyrenomycetes (fig. 1). They also provide information significant for control. An extensive series of investigations also is in progress on the black mildew fungi on Compositae. Morphological features, disease symptoms, and other biological characteristics of black mildews are under study for the preparation of monographic publications.

In research on fungi significant in the agricultural environment, growth temperature ranges have been determined in isolates of approximately 60 species of the cellulolytic genus *Chaetomium*. Spore anatomy and other physical and biological characteristics also are under study in this genus and in others that may be active in breakdown of organic wastes and debris, as in composting processes. Other recent or current projects include studies of hyphal yeasts, fungus-insect relationships, and fungal pathogens of insects (fig. 2).

The National Fungus Collections also is involved with research on noncultivated mushrooms. Some work has been ecological, but major emphasis is on taxonomy. Massive data have been assembled on poisonous mushrooms and mushroom poisoning. Recently a manuscript was prepared for a manual on significant poisonous mushrooms of the United States. Mushrooms of lawns currently are under study. Also, important mushroom genera are under investigation, with emphasis on *Agaricus* and *Amanita*. Ecological

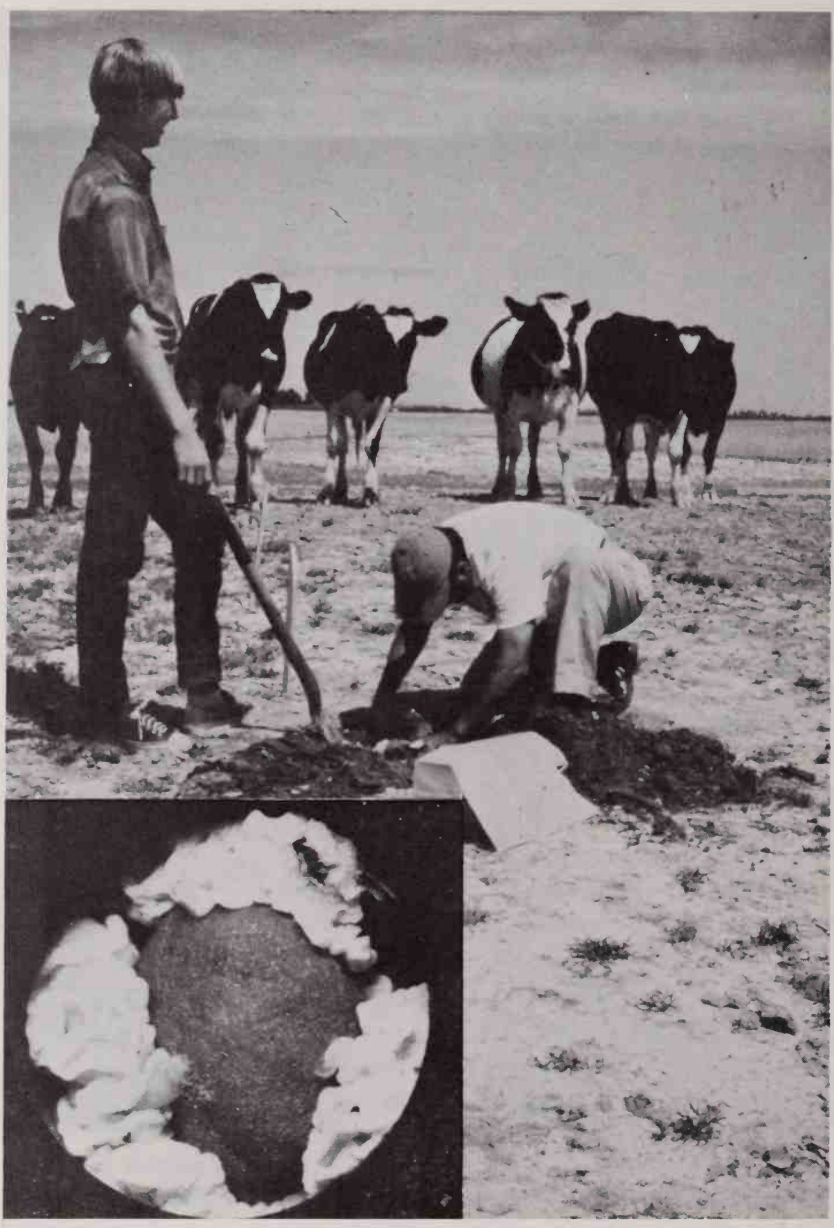


PN-5472

FIGURE 1.—ARS mycologist studying developmental stages of a new species of *Neurospora.*

research includes a project on the fleshy fungi of high altitude spruce-fir forests in the Western States.

A look into the future suggests that the National Fungus Collections will continue to grow in its significance for mycological research and the taxonomy of plant pathogens. The mycological herbarium will have 1 million collections at the end of the 20th century. A complete record of type specimens will exist. As a consequence of automation, herbarium collections will be rearranged



PN-5473

FIGURE 2.—Removing alkali bee nest for study of fungi that spoil pollen ball (insert, X 6).

whenever necessary in response to changes in taxonomy and nomenclature. Host and distribution data and synonymy may be provided upon demand. Taxonomic research will continue to serve the needs of improved plant disease diagnosis. Emphasis on collections of foreign pathogens will continue as technical support for procedures to prevent the introduction and spread of

foreign plant diseases. The National Fungus Collections will have a complete inventory and descriptions of all known poisonous mushrooms in North America, and most of the species will be represented in the herbarium. Cytological and life-history studies will validate or modify taxonomic concepts attained by other methods. Research projects will support the view that fungal taxonomy is a reflection of biology and thus a key to applied mycology and the control of pathogens.

Selected Achievements

1909 Detected first known American case of mushroom industry-threatening bubbles disease
1910 Discovered first known importation of dangerous potato wart disease in America
1915 Published first comprehensive and authoritative U.S. Government manual on noncultivated mushrooms
1925 Revealed major newly recognized group of plant pathogens, as represented by citrus-scab fungus
1926 Characterized all known pathogens and diseases of *Hevea* rubber trees in South America
1927 Established fundamental significance of *Neurospora* to development of modern research in fungal genetics
1931 Developed comprehensive taxonomic key to genera of fungi in English
1941 Climaxed research on entomogenous fungi with checklist of fungal pathogens of insects in America
1950 Monographed *Balansia,* a genus of fungi causing sterility in grasses
1954 Organized definitive system for use in specialized hyphal morphology for classifying wood-decay fungi
1955 Monographed *Stereum,* an important genus of wood-decay and tree-disease fungi
1973 Monographed Nenatosporaceae, including phytopathogenic yeasts with insect vectors
1975 Documented all known fungi of Puerto Rico in most comprehensive technical inventory available for specific large tropical area
1976 Monographed Myxomycetes of American Tropics

Selected Publications

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INSECTS

ARS COTTON INSECT COLLECTION

Boll Weevil Research Laboratory

By WILLIAM H. CROSS

Location: Boll Weevil Research Laboratory, P.O. Box 5367, Mississippi State, Miss. 39762
Loans: To recognized scientists and institutions
Associated libraries: 200 volumes
Number of accessions: 27,000 specimens, 1,800 species
Types: None
Curator: William H. Cross, (601)-323-2230, or FTS 490-4676

Background

The ARS Cotton Insect Collection was established in 1961, with the main emphasis on the Coleoptera, Hemiptera, Hymenoptera (especially boll weevil parasites), and Odonata. Other orders are also represented. Its primary purpose is to support the study of the relationship of insects to cultivated cotton and other species of the Malvaceae.

Specimens have been obtained by various methods, such as traps (fig. 1) designed to capture boll weevils (*Anthonomus grandis*); several types of vacuum machines, nets, and other devices; blacklight traps; and boxes to hold fruiting forms for emergence of adult insects. The collection also includes parasites from a much older collection originally housed at the former USDA laboratory at Tallulah, La. The collection is complemented by another one nearby in the Mississippi State University Department of Entomology that is somewhat oriented to cotton with special emphasis on predators of cotton pests. A catalog with 3,440 entries is complete back to 1967. A card file includes all identified material arranged taxonomically and cross-indexed alphabetically.

Service Identification

The curator makes preliminary determinations of hymenopterous parasites of the boll weevil.

Research

With the cooperation of several graduate students and two other entomologists at this laboratory, William L. McGovern and William L.

PN-5474

FIGURE 1.—Scientist removing boll weevils from pheromone trap (Leggett type).

Johnson, several studies have been completed on various hymenopterous parasites of the boll weevil. Also, the relationships of boll weevils to their host plants have been studied.

Selected Publications

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U.S. NATIONAL MUSEUM OF NATURAL HISTORY ENTOMOLOGICAL COLLECTION

Systematic Entomology Laboratory
Insect Identification and Beneficial Insect Introduction Institute

By DOUGLASS R. MILLER

Location: Buildings 003 and 004, BARC–West, Beltsville, Md. 20705, and National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560

Loans: To recognized institutions and scientists

Associated libraries: Over 6,000 volumes, 3,000 linear feet of reprints

Number of accessions: 24 million specimens

Types: 90,000 primary types

Curators: Although the Smithsonian scientists have ultimate authority for the curation of the collection and hold the title of curator, U.S. Department of Agriculture (USDA) scientists have considerable curatorial functions and manage the major part of the collection in addition to having heavy service identification responsibilities. As USDA employees they do not carry the title of curator. Donald R. Davis, chairman of the Department of Entomology, Smithsonian Institution (SI), would be considered head curator of entomology if such a designation were still in use.

Scientists with a telephone prefix of 447 are in area code 202 and are USDA personnel located at the National Museum of Natural History; the prefix 381 is used by Smithsonian personnel in the National Museum of Natural History; and the prefix 344 is in area code 301 and is used by USDA personnel in Beltsville.

Donald M. Anderson (447–5336) (USDA)

Research: Immature Coleoptera, especially Curculionidae; adult Scolytidae

Identification and curatorial responsibilities: Scolytoidea, immature stages of Curculionidae, Scolytoidea, Scarabaeoidea, Bostrichoidea, Cerambycidae, and most other Phytophaga to family

Edward W. Baker (344–3890) (USDA)

Research: Agricultural mites and general acarology

Identification and curatorial responsibilities: Certain parasitic Mesostigmata, Scutacaridae, Prostigmata (except Cunaxidae, Cheyletidae, and Erythraeidae), and Acaridae

Suzanne W. T. Batra (344–2384) (USDA)
Research: Ecology, behavior, and management of Apoidea; insect-fungus symbiosis
Identification and curatorial responsibilities: Apoidea

Doris H. Blake (381–6171) (research associate, SI)
Research: Chrysomelidae, especially of U.S. and West Indies
Curatorial responsibilities: None

Barnard D. Burks (344–3185) (resident cooperating scientist, USDA)
Research: Chalcidoidea, especially Chalcididae
Identification and curatorial responsibilities: None

John M. Burns (381–5523) (SI)
Research: Evolutionary biology; systematics and biology of Lepidoptera, especially Hesperioidea and Papilionoidea
Curatorial responsibilities: Hesperioidea

Robert W. Carlson (447–5305) (USDA)
Research: Ichneumonid subfamily Campopleginae; catalog of Nearctic Ichneumonidae
Identification and curatorial responsibilities: Stephanidae, Ichneumonidae, Evanioidea, Trigonalidae, and Megalyridae

Oscar L. Cartwright (381–5375) (research associate, SI)
Research: Scarabaeidae (Aphodiinae)
Curatorial responsibilities: None

Jack F. Gates Clarke (381–5327) (research associate, SI)
Research: Microlepidoptera
Curatorial responsibilities: Exotic Microlepidoptera

Ralph E. Crabill, Jr. (381–5405) (SI)
Research: Chilopoda
Curatorial responsibilities: Chilopoda, Diplopoda, Symphyla, Pauropoda, Arachnida, and Onychophora

Donald R. Davis (381–5316) (SI)
Research: Zeugloptera, Dacnonypha, Monotrysia, Tineoidea; biology of leaf-mining and cave-dwelling moths
Curatorial responsibilities: Zeugloptera, Dacnonypha, Monotrysia, and Tineoidea

W. Donald Duckworth (381–5629) (SI)
Research: Stenomidae and Sesiidae
Curatorial responsibilities: Yponomeutioidea and Gelechioidea (part)

K. C. Emerson (381–6454) (research associate, SI)
Research: Mallophaga and Anoplura
Curatorial responsibilities: Same

Terry L. Erwin (381–5410) (SI)
Research: Carabidae
Curatorial responsibilities: Carabidae, Rhysodidae, Amphizoidae, and Staphylinidae

Douglas C. Ferguson (447–5280) (USDA)
Research: Arctiidae, Geometridae, Lymantriidae, and certain other Noctuoidea, Saturniidae, particularly of North America; Holarctic and Pleistocene biogeography
Identification and curatorial responsibilities: Drepanoidea, Geometroidea, Uranioidea, and Pyraloidea

William D. Field (381–5616) (SI)
Research: Papilionoidea, especially Pieridae, Nymphalidae, and Lycaenidae
Curatorial responsibilities: Rhopalocera:Papilionoidea

Oliver S. Flint, Jr. (381–5444) (SI)
Research: Trichoptera and Megaloptera of the New World
Curatorial responsibilities: Trichoptera, Plecoptera, Ephemeroptera, Odonata, Neuroptera, Mecoptera, Collembola, Thysanura, Diplura, and Protura

Richard H. Foote (447–8512) (USDA)
Research: Tephritidae, Pyrgotidae, and Psilidae; information handling in biology
Identification and curatorial responsibilities: Tephritidae, Pyrgotidae, and Psilidae

Richard C. Froeschner (381–5628) (SI)
Research: Hemiptera-Heteroptera, especially Tingidae and Pentatomoidea
Curatorial responsibilities: Hemiptera-Heteroptera

Raymond J. Gagné (447–2297) (USDA)
Research: Cecidomyiidae, Mycetophilidae, and some calypterate Diptera
Identification and curatorial responsibilities: Sciaridae, Mycetophilidae, Scatopsidae, Cecidomyiidae, Muscidae, Glossinidae, Gasterophilidae, Calliphoridae, Sarcophagidae, and Oestridae

Gordon Gordh (447–5578) (USDA)
Research: Parasitic Hymenoptera; mating behavior
Identification and curatorial responsibilities: Chalcidoidea

Robert D. Gordon (447–5245) (USDA)
Research: Coccinellidae and Scarabaeidae of the Western Hemisphere
Identification and curatorial responsibilities: Scarabaeoidea, Lampyroidea, Meloidae, Orthoperidae, and Coccinellidae (Staphylinidae for biological control purposes only)

Ashley B. Gurney (447–3379) (resident cooperating scientist, USDA)
Research: New World cockroaches and grasshoppers; Zoraptera of the world
Identification and curatorial responsibilities: None

Jon L. Herring (447–5609) (USDA)
Research: Anthocoridae, marine Heteroptera, and Heteroptera of economic importance, especially Coreidae, Lygaeidae, and Miridae
Identification and curatorial responsibilities: Heteroptera (except Belostomatidae and Gelastocoridae)

Ronald W. Hodges (344–3183 and 447–5497) (USDA)
Research: Gelechioidea, especially of North America; Sphingidae of the New World
Identification and curatorial responsibilities: Gelechioidea (except Stenomidae and Xyloryctidae)
Yiau-Min Huang (381–5050) (SI)
Research: Culicidae: *Aedes* (*Stegomyia*)
Curatorial responsibilities: Culicidae: *Aedes* (*Stegomyia*)
Paul D. Hurd, Jr. (381–6240) (SI)
Research: Apoidea; intrafloral ecology and pollination
Curatorial responsibilities: Apoidea
John M. Kingsolver (447–5409) (USDA)
Research: Bruchidae, especially of the Western Hemisphere
Identification and curatorial responsibilities: Histeroidea, Dascilloidea, Byrrhoidea, Dermestoidea, Buprestidae, Trogositidae, Bruchidae, and miscellaneous families in Staphylinoidea, Cucujoidea, Dryopoidea, and Coccinelloidea; larval Dermestidae, Bruchidae, and Buprestidae
Lloyd Knutson (344–3182 and 447–5347) (USDA)
Research: Empididae of North America, especially *Megacyttarus;* immature Diptera; Sciomyzidae and their use as biological control agents of snail hosts of heminthid parasites
Identification and curatorial responsibilities: Asiloidea, Empididae, and Sciomyzidae
James P. Kramer (447–5609) (USDA)
Research: Cicadellidae of the New World; Fulgoroidea of U.S.
Identification and curatorial responsibilities: Fulgoroidea, Cicadelloidea, Cicadidae, Membracidae, and Cercopidae
Karl V. Krombein (381–5547) (SI)
Research: Ceylon Insect Project; bionomics and ethology of bees and wasps; scolioid and sphecoid wasps; computerized catalog of North American Hymenoptera
Curatorial responsibilities: Voucher specimens from studies on bionomics and ethology of wasps; Ceylon Insect Project specimens
Paul M. Marsh (447–2952) (USDA)
Research: Braconidae
Identification and curatorial responsibilities: Braconidae, Pelecinidae, and Proctotrupoidea
Wayne N. Mathis (381–5371) (SI)
Research: Drosophiloidea, especially Ephydridae
Curatorial responsibilities: Diptera
Arnold S. Menke (447–2953) (USDA)
Research: Sphecidae and Belostomatidae
Identification and curatorial responsibilities: Bethyloidea, Scolioidea, Vespoidea, Pompiloidea, Sphecoidea, Cynipoidea, and Belostomatidae
Douglass R. Miller (344–3895) (USDA)
Research: Eriococcidae and Pseudococcidae
Identification and curatorial responsibilities: Coccoidea

C. F. W. Muesebeck (381–5618) (resident cooperating scientist, USDA, and research associate, SI)
Research: Proctotrupoidea
Identification and curatorial responsibilities: None

Sueo (Steve) Nakahara (344–3894) (Animal and Plant Health Inspection Service (APHIS))
Research: Coccidae and Diaspididae
Identification responsibilities: Coccoidea and Thysanoptera for APHIS

Kellie O'Neill (344–3893) (USDA)
Research: Plant-feeding and predatory Thysanoptera
Identification and curatorial responsibilities: Thysanoptera

E. L. Peyton (381–5050) (SI)
Research: Culicidae: *Anopheles* and *Uranotaenia*
Curatorial responsibilities: Culicidae

Louise M. Russell (344–3896) (resident cooperating scientist, USDA)
Research: Aleyrodidae, Aphidoidea, and Psyllidae
Identification and curatorial responsibilities: None

Curtis W. Sabrosky (447–6370) (USDA)
Research: Chloropidae, Tachinidae; *Cuterebra, Protocalliphora,* and *Stenomicra;* zoological nomenclature
Identification and curatorial responsibilities: Milichiidae, Carnidae, Chloropidae, Aulacigastridae, Odiniidae, Anthomyzidae, Asteiidae, Tachinidae, Rhinophoridae, and Cuterebridae

Sunthorn Sirivanakarn (381–5050) (SI)
Research: Culicidae: *Culex*
Curatorial responsibilities: Same

Robert L. Smiley (344–3891) (USDA)
Research: Cheyletiellidae, Cheyletidae, Cunaxidae, and Tarsonemidae
Identification and curatorial responsibilities: Certain free-living Mesostigmata, Tarsonemoidea, Cunaxidae, Cheyletidae, and Cheyletiellidae

David R. Smith (447–5345) (USDA)
Research: Symphyta
Identification and curatorial responsibilities: Symphyta and Formicidae; (Isoptera for APHIS only)

Paul J. Spangler (381–5297) (SI)
Research: Aquatic Coleoptera
Curatorial responsibilities: Dytiscidae, Haliplidae, Gyrinidae, Hydrophilidae, and other aquatic Coleoptera

Theodore J. Spilman (447–2983) (USDA)
Research: Tenebrionidae and relatives
Identification and curatorial responsibilities: Cupesoidea, Silphidae, Lymexylonidae, Tenebrionoidea, Cucujidae, Cerambycidae, Elateroidea, and miscellaneous families in Melodidea and Bostrichoidea; Stylopidae

George Steyskal (447–5341) (USDA)
Research: Agromyzidae and Anthomyiidae
Identification and curatorial responsibilities: Anthomyiidae, Agromyzidae, and majority of other acalyptrate families

Manya B. Stoetzel (344–3168) (USDA)
Research: Aleyrodidae, Aphidoidea, Diaspididae, and Psyllidae
Identification and curatorial responsibilities: Aphidoidea, Psyllidae, and Aleyrodidae

F. Christian Thompson (447–2439) (USDA)
Research: Syrphidae; biogeography of Diptera
Identification and curatorial responsibilities: Psychodidae, Culicoidea (except Culicidae, Ceratopogonidae, and Chironomidae), Bibionoidea, Dolichopodidae, Syrphoidea, Tabanidae, Anisopodidae, Braulidae, Hippoboscidae, Streblidae, and Nycteribiidae

Edward L. Todd (447–2374) (USDA)
Research: Noctuoidea of the New World, especially acontiine groups; Gelastocoridae
Identification and curatorial responsibilities: Noctuoidea and Gelastocoridae

Robert Traub (381–5098) (research associate, SI)
Research: Systematics and disease transmission of Siphonaptera and trombiculid mites; zoogeography and convergent evolution
Curatorial responsibilities: Siphonaptera

Donald L. Weisman (447–2374) (USDA)
Research: Immature Lepidoptera of economic importance
Identification and curatorial responsibilities: Immature stages of all Lepidoptera

Richard E. White (447–5203) (USDA)
Research: Anobiidae and Chrysomelidae
Identification and curatorial responsibilities: Anobiidae, Chrysomelidae, Anthribidae, Brentidae, and Cleridae

Donald R. Whitehead (447–5229) (USDA)
Research: Carabidae and Curculionidae; Central American biogeography; theoretical systematics
Identification and curatorial responsibilities: Curculionidae

Willis W. Wirth (447–4546) (USDA)
Research: Aquatic Diptera, especially Ceratopogonidae and Ephydridae
Identification and curatorial responsibilities: Ceratopogonidae, Chironomidae, Lonchopteroidea, Phoroidea, Ephydridae, Canaceidae, and majority of families in Tabanoidea and Drosophiloidea

Background

The national entomological collection is the first or second largest in the world and is increasing at a surprising rate; e.g., in 1975 the Smithsonian Institution accessioned over 750,000 insect specimens. The collection serves as a primary repository for insects of the United States, but it also has large holdings of material from all parts of the world. Specimens in the collection are used as a basis for important systematic research and are a critical part of the research programs of most fields of entomology. The large holdings of agriculturally important species make this collection especially significant as a source of systematic research and service identification of insect pests.

Entomologists outside the Washington, D.C., area are frequently confused about the relationship of the U.S. Department of Agriculture's Systematic Entomology Laboratory (SEL) and the Smithsonian Institution's Department of Entomology. This confusion results from a long history of cooperation between these distinct and separate organizations. During the early history of U.S. systematic entomology, C. V. Riley served concurrently as chief entomologist for USDA and honorary curator of insects (functional, unpaid position) for the Smithsonian; L. O. Howard also served in this double role. Since then, USDA and Smithsonian personnel have successfully worked in concert toward the goal of developing a large and useful national collection of insects.

In 1925, USDA entomological taxonomists were assigned to a division of the Bureau of Entomology; this division has been maintained to the present with a few changes in name and rank. The current organization, the Systematic Entomology Laboratory, is one of two laboratories in the Insect Identification and Beneficial Insect Introduction Institute.

Although the U.S. National Museum (USNM) was established in 1842, the first record of an insect collection actually stored in the museum does not appear until 1858. Because of insufficient funds in the 1860's, most of the Smithsonian's USNM insect collection was sent to collaborating specialists with the stipulation that the material could be reclaimed at any time. By the early 1870's the USDA was made the repository for the Smithsonian insect collection, which was added to the USDA collection. The latter began with the acquisition of the personal collection of Townend Glover, the first chief entomologist of the USDA. From 1867 until 1881 the collection grew and thrived through the efforts of Glover, Riley, and J. H. Comstock. In 1881, with Riley's reappointment as chief entomologist, the USDA insect collection was officially transferred to the National Museum of the Smithsonian Institution. With Riley's gift of his personal collection in 1886, the holdings of insects in the USNM had reached the status of a major entomological repository. In 1969, the name of the former U.S. National Museum was officially changed to the National Museum of Natural History.

The first salaried Smithsonian entomologist was J. B. Smith, who served as assistant curator from 1885 to 1889. He was succeeded by Martin Linell, who was a museum aide from 1889 to 1897. From 1897 until 1940 the Smithsonian had only two salaried positions in entomology, excluding clerical assistants. From 1940 to the present the scientific staff has expanded to 15 full-time scientists, several research associates, and a large support staff.

Service Identification

The service responsibilities of the Systematic Entomology Laboratory are extensive. Since 1972, about 270,000 specimens have been identified each year, and approximately 52,000 specimens are added annually to the national entomological collection. The yearly determinations since 1972 average about 80,000, and 25,000 lots have been identified each year. These identifications provide basic support for biological control projects, environmental studies,

and diverse research, extension, and control activities of Federal and State agencies and other organizations in the United States and abroad.

Material submitted for identification should be sent to Lloyd Knutson, Chairman, Insect Identification and Beneficial Insect Introduction Institute, room 1, building 003, BARC-West, Beltsville, Md. 20705. Instructions for specimen preparation may be obtained by writing to Edna Hoover at the same address. Submitted material is processed by the Identification Services Unit and is sent to the appropriate specialist. In addition to the SEL and certain Smithsonian staff members, some of the following SEL cooperating scientists may also provide identifications: H. W. Allen, R. H. Arnett, Jr., W. F. Barr, A. D. Bratt, G. W. Byers, C. M. Clifford, W. A. Connell, T. D. Eichlin, J. G. Franclemont, G. E. Gates, E. J. Gerberg, E. J. Hambleton, H. H. Keifer, K. C. Kim, H. Lanchester, E. L. Mockford, W. B. Peck, W. L. Peters, M. W. Sanderson, A. Stone, C. Tauber, M. J. Tauber, and D. L. Wray.

Research

Research in SEL is generally directed toward insect groups of economic importance to American agriculture. Because of possible overlap, great care is taken to avoid duplication of effort between USDA and Smithsonian systematists, and assignments of research areas and of responsibility for curation of the collection are carefully coordinated.

The research record of SEL is impressive. From 1973 to 1975 the laboratory each year has averaged 125 research publications, among which are many major revisionary works and books.

The laboratory has compiled extensive card catalogs, comprising about 9 million cards. They have served as the basis for the many published catalogs and bibliographies written by SEL scientists.

The Chief of the Systematic Entomology Laboratory is Ronald W. Hodges. The laboratory is divided into five research units, which are organized mainly by ordinal category. Each unit is coordinated by a lead scientist.

Coleoptera Research Unit

The Coleoptera Research Unit is located on the sixth floor, west wing, Natural History Museum, Washington, D.C. The associated library includes 1,060 volumes and 200 linear feet of reprints. The Coleoptera collection consists of more than 7 million specimens, stored in about 12,000 drawers, and includes nearly 20,000 types. The SEL staff includes J. M. Kingsolver (lead scientist), D. M. Anderson, R. D. Gordon, T. J. Spilman, R. E. White, and D. R. Whitehead. The Smithsonian staff comprises D. H. Blake (research associate, USNM), O. L. Cartwright (retired; research associate, USNM), T. L. Erwin, and P. J. Spangler.

The nucleus of the Coleoptera collection was formed in 1881 with the transfer of the general USDA collection to the USNM. The appointment of E. A. Schwarz (USDA) in 1897 as honorary curator of Coleoptera brought with it the large and valuable Hubbard and Schwarz collection, which made the USNM collection one of the largest in the world. Since the early 1900's, distinguished

coleopterists have been associated with the USNM collection. USDA employees include W. H. Anderson, R. H. Arnett, Jr., H. S. Barber, R. S. Beal, M. W. Blackman, R. E. Blackwelder (subsequently USNM), A. G. Böving, J. C. Bridwell, L. L. Buchanan, E. A. Chapin (subsequently USNM), W. S. Fisher, W. D. Pierce, J. G. Rozen, Jr., P. J. Spangler (subsequently USNM), G. B. Vogt, L. M. Walkley, and R. E. Warner.

The collection is strongest in Western Hemisphere species, especially the Anobiidae, aquatic and semiaquatic families, Bruchidae, Buprestidae, Carabidae, Cerambycidae, Chrysomelidae, Cicindellidae, Cleridae, Coccinellidae, immature Coleoptera, Curculionidae, Elateridae, Lampyridae, Mordellidae, Oedemeridae, Phengodidae, Scarabaeidae, Scolytidae, and Neotropical Staphylinidae.

Major collections are those of C. F. Baker, H. S. Barber, H. S. Barber and Schwarz, Belfrage, Blackman, Bovie, Burke, Cartwright, Casey, Chapin, Dieke, Eggers, Erwin, Halik and Daguerre, Harriman, Hopkins, Hubbard and Schwarz, Kissinger, Koebele, Lane, Linell, Mac Swain, Monros, Morrison, Murayama, Pena, Riley, Robinson and Shoemaker, Rosenberg, Schaeffer, Sherman, J. B. Smith, Tippman, Turner, and Wickham.

Current and future major areas of SEL research include Coccinellidae of the United States and Canada; immature forms of heteromerous Coleoptera and the Curculionoidea; Anobiidae, Bruchidae, Coccinellidae, and Curculionidae of the Western Hemisphere; and a computerized catalog of the Coleoptera of American north of Mexico.

Diptera Research Unit

The Diptera Research Unit is located on the sixth floor, west wing, Natural History Museum, Washington, D.C. L. Knutson also has an administrative office at Beltsville (rm. 1, bldg. 003). The associated library includes 550 volumes and 500 linear feet of reprints. The Diptera collection comprises more than 5,300 drawers of pinned specimens, 470,000 slide-mounted specimens, and 17 quarter cases of specimens in alcohol. There are about 20,000 primary types. The SEL staff includes R. J. Gagné (lead scientist), R. H. Foote, L. Knutson, C. W. Sabrosky, G. C. Steyskal, F. C. Thompson, and W. W. Wirth. The Smithsonian dipterist is W. Mathis. The Medical Entomology Project staff employed by the Smithsonian includes Y.-M. Huang, E. L. Peyton, and S. Sirivanakarn.

In 1886, the USDA appointed S. W. Williston as the first dipterist associated with the USNM Diptera collection. Since then the following USDA specialists have undertaken research on the taxonomy of Diptera: D. W. Coquillett, C. T. Greene, D. G. Hall, J. R. Malloch, R. C. Shannon, A. Stone, and C. H. T. Townsend. Other than W. Mathis, J. M. Aldrich was the only dipterist appointed by the Smithsonian.

The collection is one of the best in the world and is strongest in Nearctic and Neotropical material. The best represented families are Asilidae, Bombyliidae, Calliphoridae, Cecidomyiidae, Ceratopogonidae, Chloropidae, Culicidae,

Empididae, Ephydridae, Muscidae, Sarcophagidae, Sciomyzidae, Tachinidae, Tephritidae, and Tipulidae.

Major collections are those of Aldrich, Baranov, Belkin, Bromley, Burgess, Coquillett, Dyar, Hoogstraal, King, Knight, Ludlow, Malloch, Melander, Painter, Pritchard, Roseboom, Shannon, Steyskal, Sturtevant, Thompson, Thurman, Williston, and Wirth. The National Museum has recently acquired title to the C. P. Alexander collection, which is probably the best private collection of flies ever amassed. It includes more than 11,000 of the 14,000 species of crane flies and over 8,000 holotypes. The mosquito collection has been significantly expanded in recent years by two Smithsonian contracts with the U.S. Army. By means of these contracts the former Southeast Asia Mosquito Project and the present Medical Entomology Project have accessioned more than 250,000 specimens of mosquitoes.

Current and future major areas of SEL research include a computerized catalog of the Diptera of the world; keys to the genera of Neotropical fruit flies (Tephritidae) and to species of *Anastrepha;* flower flies (Syrphidae) of North America; gall midges (Cecidomyiidae) of conifers, especially the pine pitch midges, genus *Cecidomyia*; generic classification of the biting midges (Ceratopogonidae); bird blow flies (*Protocalliphora*) and rodent bots (*Cuterebra*); tachinid parasites of crop pests; and evolution of the Sciomyzidae.

Hymenoptera Research Unit (including Isoptera)

Hymenoptera.—The Hymenoptera Research Unit is located on the second floor, hall 27, Natural History Museum, Washington, D. C., except Batra and Burks, who have offices in building 417, Beltsville. The associated library includes 200 volumes and 400 linear feet of reprints. The Hymenoptera collection consists of about 2 million pinned specimens (fig. 1), stored in more than 4,300 drawers, and includes more than 15,000 holotypes. The SEL staff consists of P. M. Marsh (lead scientist), S. W. T. Batra, B. D. Burks, R. W. Carlson, G. Gordh, A. S. Menke, and D. R. Smith. The Smithsonian staff includes P. D. Hurd, K. V. Krombein, and C. F. W. Muesebeck.

The nucleus of the Hymenoptera collection was formed by such early workers as Riley, Pergande, Schwarz, and Howard, but the USNM Hymenoptera holdings first acquired the status of a major collection with the acquisition of the Ashmead collection in 1898. Ashmead was appointed in 1887 by the USDA to work on insect pests and their parasites. From 1897 to 1908 he was employed by the Smithsonian Institution as assistant curator and thus was the first USNM hymenopterist. J. C. Crawford succeeded Ashmead as assistant curator in 1908 and centered his research on the Chalcidoidea. During Crawford's tenure, several USDA scientists were assigned to the museum to work principally on parasitic wasps and sawflies. These individuals were R. A. Cushman, A. B. Gahan, A. A. Girault, S. A. Rohwer, and H. L. Viereck. Other USDA hymenopterists associated with the collection have been B. D. Burks (retired; now resident cooperating scientist with SEL), K. V. Krombein (subsequently USNM), W. M. Mann, C. L. Marlatt, C. F. W. Muesebeck (retired;

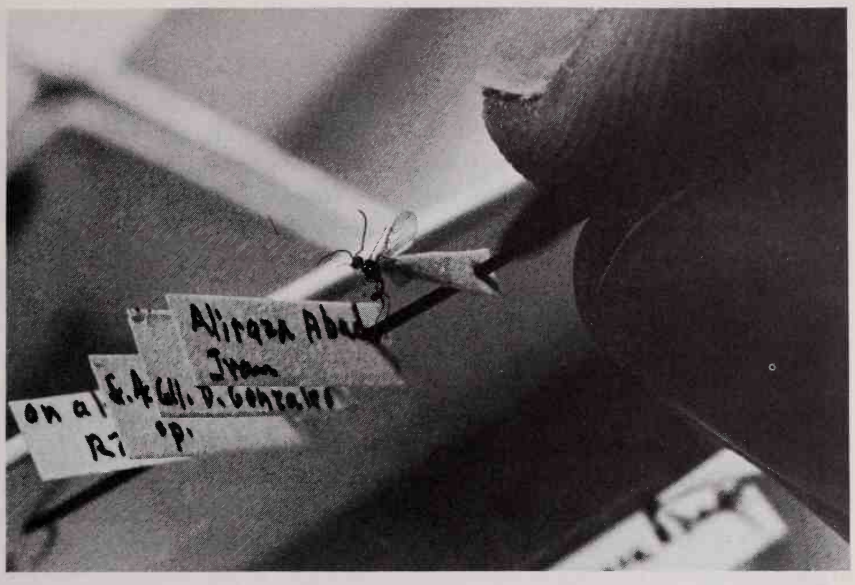

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FIGURE 1.—Pinned specimen of an aphid parasite, *Praon dorsale.*

cooperating scientist, SEL, and research associate, USNM), G. A. Sandhouse, M. R. Smith, H. Townes, L. Walkley, and L. H. Weld.

Areas of the collection especially well represented include Aculeata, Chalcidoidea, Chalcidoidea larvae, Cynipoidea, Ichneumonoidea, Proctotrupoidea, and Symphyta. Major collections are those of Ashmead, C. F. Baker, Cooper, Hurd, Krombein, Mann, Priesner, and Stelfox.

Current and future major areas of SEL research include a computerized catalog of North American Hymenoptera; parasites of *Heliothis* and of the gypsy moth; revision of the Nearctic species of the ichneumonid genus *Phobocampe;* revision of several North American chalcidoid genera; biology and sexual behavior of the chalcidoid genus *Aphelinus;* sexual behavior of insects; revision of bark-beetle parasites in the braconid subfamily Doryctinae in North and South America; Symphyta of South America; world genera of the sawfly tribe Fenusini; and a catalog of world species of Xiphydriidae, Siricidae, and Syntexidae.

Isoptera.—The termite collection is located on the fourth floor, hall 27, Natural History Museum, Washington, D.C. The associated library includes about 100 volumes and 60 linear feet of reprints. The collection consists of 240,000 specimens, with examples of 1,286 species, and includes 943 types. At present no one is conducting research on termites at the USNM, although D. R. Smith is responsible for service identifications of isopterans.

The termite collection is one of the largest in the world, primarily through the efforts of T. E. Snyder (USDA). The collection has worldwide representation and is especially rich in species from the West Indies, Central America, and the Amazon Basin.

Lepidoptera.—The Lepidoptera collection is located on the second floor, hall 30, Natural History Museum, Washington, D.C. R. W. Hodges also has an administrative office at Beltsville (rm. 2, bldg. 003). The associated library includes about 1,000 volumes and 280 linear feet of reprints. The Lepidoptera collection occupies about 30,000 drawers and contains about 25,000 primary types (fig. 2). The lepidopterous larval collection is the largest in the world. The SEL staff includes D. C. Ferguson (lead scientist), R. W. Hodges, E. L. Todd, and D. M. Weisman. The Smithsonian staff comprises J. M. Burns, J. F. G. Clarke (retired; research associate with USNM), D. R. Davis, W. D. Duckworth, and W. D. Field.

The first specialist to work on Lepidoptera at the USNM was J. B. Smith, who was employed by the Smithsonian Institution in 1885. Since then the following USDA employees have undertaken Lepidoptera systematic research: F. Benjamin, A. Busck, H. Capps, J. F. G. Clarke (subsequently USNM), H. G. Dyar, J. G. Franclemont, C. Heinrich, and W. Schaus.

The collection is strongest in Nearctic holdings and is progressively less rich in Neotropical, Palaearctic, Oceanic, Oriental, Australian, and Ethiopian material. Especially well represented are Palaearctic Lycaenidae, Japanese and Formosan Microlepidoptera, Neotropical Geometridae, Philippine Lepidoptera, Szechwan (China) Macrolepidoptera, Egyptian Lepidoptera, and Nearctic Sesiidae.

Major acquisitions incorporated in the Lepidoptera holdings are collections of Alfieri, C. F. Baker, Barnes, Blackmore, A. Blanchard, Box, The Brighton Museum, The Brooklyn Museum, Clarke, Dognin, Dyar, Engelhardt, Ferguson, Fernald, Field, Franclemont, Graef, Grossbeck, Hodges, Issiki, McAlpine, Merrick, Neumoegen, Philpott, Schaus, Smyth, and Taylor. The Jäckh collection (Palaearctic microlepidoptera) currently is being purchased jointly by USDA and SI. Many specimens studied by the following lepidopterists are also incorporated in the collection: Boisduval (North American species), Diakonoff, Guenée (North American species), Hulst, McDunnough, McElvare, Munroe, Rindge, Shaffer, and Warren.

Current and future major areas of SEL research include continued revisionary works for the publication "Moths of America North of Mexico," checklist of the Lepidoptera of North America, catalog of the type-specimens of North America Noctuoidea described by J. B. Smith, taxonomic and biogeographic study of the Noctuoidea of the West Indies, and generic classification of the Gelechioidea of the world.

Heteroptera.—The Heteroptera collection is located on the second floor, hall 30, Natural History Museum, Washington, D.C. The associated library includes 300 volumes and 70 linear feet of reprints. The Heteroptera collection occupies about 2,500 drawers and contains about 4,000 holotypes. The SEL staff member is J. L. Herring; Menke and Todd devote some research effort to the Heteroptera. The Smithsonian staff member is R. C. Froeschner.

In 1898, O. Heidemann was employed by the USDA to study the systematics of the Heteroptera. Since then the following USDA specialists have

PN-5476

FIGURE 2.—Extensive Lepidoptera range of national entomological collection.

undertaken Heteroptera systematic research: P. D. Ashlock, H. G. Barber, R. C. Froeschner (subsequently USNM), E. H. Gibson, W. L. McAtee, and R. I. Sailer.

The collection is strongest in New World specimens but is also well represented in Philippine material. Especially strong areas are Aradidae,

Cimicidae, Lygaeidae, Miridae, Ochteridae, Phymatidae, and Tingidae. Major collections are those of C. F. Baker, Barber, Drake, Hacker, Knight, Kormilev, McAtee, Pennington, Reed, and Uhler. Many specimens studied by the following heteropterists are in the collection: Carvalho, Harris, Maldonado, Slater, and Usinger.

Current and future major areas of SEL research include a catalog of the Heteroptera of America north of Mexico; Anthocoridae of North America; plant-feeding bugs of the families Miridae and Coreidae, especially of North America; and semiaquatic and aquatic Heteroptera of California.

Auchenorrhyncha.—The Auchenorrhyncha collection is located on the second floor, hall 30, Natural History Museum, Washington, D.C. The associated library includes 250 volumes and 48 linear feet of reprints. The collection is stored in 1,550 drawers and has about 2,400 holotypes. The SEL staff member is J. P. Kramer.

The first full-time Auchenorrhyncha homopterist associated with the USNM collection was P. W. Oman, who was employed by the USDA in 1931. Since then J. S. Caldwell and D. A. Young have served as USDA homopterists. The strength of the Auchenorrhyncha collection is in the Cicadellidae owing to the efforts of Kramer, Oman, and Young. Major acquisitions incorporated in the Homoptera holdings are the collections of C. F. Baker, Ball, Buys, Caldwell, Funkhouser, Goding, Hacker, McAtee, and Uhler. The collection also contains many types described by Davis, Fennah, Kramer, Osborn, and Van Duzee.

Current and future major areas of research include revisions of the planthopper genera *Crypoptus, Haplaxius,* and *Cixius* (Fulgoroidea).

Orthoptera.—The Orthoptera collection is located on the third floor, room 428, Natural History Museum, Washington, D.C. The associated library includes 535 volumes and 57 linear feet of reprints. The collection is stored in 1,750 drawers and 2 quarter cases of alcohol material and has 670 primary types. The SEL staff member is A. B. Gurney (retired; resident cooperating scientist).

Two USDA orthopterists have concentrated their research and identification efforts on this group of insects. A. N. Caudell was employed in 1898 and A. B. Gurney in 1936. The collection is strongest in U.S. *Melanoplus* grasshoppers, Neotropical cockroaches, and grylloblattids. Major collections incorporated into the USNM holdings are those of C. F. Baker, Daguerre, and Riley.

Current and future major areas of research include revision of the *montanus* species group of the genus *Melanoplus* and the cockroach genus *Nelipophygus*.

Sternorrhyncha, Thysanoptera, Acari Research Unit

Coccoidea.—The Coccoidea collection is located in room 7, building 004, Beltsville. The associated library includes 200 volumes and 40 linear feet of reprints. The collection consists of 133,500 slides and has 238 primary types. Also included is a large collection of unmounted dry material, which contains several million specimens. The SEL staff member is D. R. Miller (lead scientist). S. Nakahara (Animal and Plant Health Inspection Service, USDA) is

responsible for the determination of scales submitted by U.S. port-of-entry identifiers. E. R. Morrison, H. Morrison, L. M. Russell, M. B. Stoetzel, and D. Williams have also worked on scale insects.

The scale insect collection has developed into one of the most important in the world primarily through the efforts of H. Morrison (USDA). Other USDA contributors are C. L. Marlatt and L. M. Russell. The collection is especially strong in New World material but also is well represented in material from Africa and Australia. Well-represented groups are Asterolecaniidae, Diaspididae, Margarodidae, and Ortheziidae. Major collections are those of Brain, Comstock, Ehrhorn, and Maskell (in part). The collection also contains many types contributed by Cockerell, Ferris, Morrison, and Russell.

Current and future major areas of research include *Coccus* of North America, checklist of the Coccoidea of America north of Mexico, handbook on the economic scale insects of the United States, Eriococcidae of North America, and Pseudococcidae and Coccidae of the United States.

Aleyrodidae, Aphidoidea, and Psyllidae.—These collections are located in room 6, building 004, Beltsville. The associated library has 200 volumes and 50 linear feet of reprints. The Aleyrodidae collection includes about 17,000 slides, 6,400 envelopes of unmounted material, 675 species, and 145 types. The aphid collection includes 62,200 slides representing 2,250 species. The psyllid collection has 21,300 pinned specimens, 2,400 slides, 3 drawers containing psyllids on their hosts, and 90 types, representing 300 species. The SEL staff comprises L. M. Russell (retired; resident cooperating scientist) and M. B. Stoetzel.

These collections were built principally through the efforts of T. Pergande, A. C. Baker, A. L. Quaintance, and L. M. Russell. They contain specimens studied by A. C. Baker, Caldwell, Crawford, Fitch, Hottes, Mason, Pergande, Quaintance, Riley, Russell, Schwarz, and Strom.

Current and future major areas of research include biosystematics of aphids on roses, *Tetraleurodes* in North America, and revisions of the whiteflies encountered in quarantine.

Thysanoptera.—The Thysanoptera collection is located in room 5, building 004, Beltsville. The associated library includes 300 volumes and 20 linear feet of reprints. The collection has about 100,000 specimens and 1,150 primary types. The SEL staff member is K. O'Neill. S. Nakahara (Animal and Plant Health Inspection Service, USDA) is responsible for the determination of thrips submitted by U.S. port-of-entry identifiers.

The Thysanoptera collection was started by T. Pergande (USDA) before 1900. No full-time thysanopterist was employed by the USDA until the late 1930's, although identifications were provided by A. C. Morgan and J. R. Watson. USDA thysanopterists include F. Andre and J. C. Crawford. Geographic areas best represented are North America, western Europe, India, and Central and South America. The most important acquisition was the purchase of the J. D. Hood collection, which has more than doubled the size of the Thysanoptera collection.

Current and future major areas of research include a revision of the *Frankliniella minuta* species group, taxonomic implications of abdominal vestiture in Thripina, and a revision of the *Frankliniella tenuicornis* species group.

Acari.—The Acari collection is located in rooms 2 and 3, building 004, Beltsville. The associated library consists of 125 volumes and 80 linear feet of reprints. The collection has about 112,000 slides and 1,850 primary types. The SEL staff members are E. W. Baker and R. L. Smiley.

Research on mites began in 1880 with the USDA employee N. Banks, who published in 1915 the first handbook on mites in English. Succeeding Banks was the USDA acarologist H. E. Ewing. The collection is especially strong in groups of economic concern to agriculture. Those well represented are the Cheyeltioidea, American parasitic and predaceous Mesostigmata, Phytoseiidae, Tetranychoidea, and Trombiculidae. Many specimens have been studied by E. W. Baker, D. DeLeon, A. Fain, A. P. Jacot, E. A. McGregor, and R. L. Smiley.

Current and future major areas of research include systematic studies of *Pygmephorus* (Pyemotidae); Cunaxidae and Tarsonemidae of the world; and plant-feeding mites of importance to agriculture, especially tetranychids and tenuipalpids.

Selected Achievements

1881 Published first major revision of scale insects of North America, including many pest species

1885 Published first comprehensive systematic treatise of chalcidoid parasites in North America

1897 Published first comprehensive revision of tachinid flies of America north of Mexico, including many important parasites

1903 Cataloged Lepidoptera of North America, including 6,622 species, with synopsis of moth and butterfly literature

1907 Published first major revision of cricket family Decticinae in North America, including 66 species and such pests as Mormon cricket

1913 Classified the whiteflies (Aleyrodidae) of the world

1923 Revised moth family Olethreutidae of North America, including many conifer and fruit tree pests, totaling 700 species

1925 Published and later revised (1952) classification of ensign scales, family Ortheziidae of the world, including 90 species

1928 Classified ground pearl family Margarodidae, including 250 species and such pests as cottony cushion scale

1931 Published first major synopsis of larval forms of beetles

1935 Published textbook on insect morphology, which standardized structural terminology

1938 Established classification of 200 Nearctic species of horseflies in subfamily Tabaninae

1941 Revised moth family Oecophoridae of North America, including 117 species and several household and vegetable pests

1941 Published classification of 150 pit scale species of the world
1942 Established classification of fruit fly genus *Anastrepha* of the world, including such important pests as Mexican fruit fly
1946 Published catalog of beetles of Mexico, West Indies, and Central and South America, including 50,000 species
1949 Cataloged termites of the world, including about 2,500 species
1951 Cataloged Hymenoptera of America north of Mexico, including 18,000 species
1952 Published textbook on study of mites; it serves as basis for acarology curricula throughout the world
1954 Revised termites of United States and Canada
1955 Published comprehensive treatise on plant-feeding spider mites and false spider mites of the world
1955 Published first of eight volumes on microlepidopterous-type specimens of Meyrick, including illustrations of over 5,000 species
1956 Revised moth subfamily Phycitinae of the New World, including over 700 species and many stored-product and forest pests
1958 Established new classification of mites of the world
1965 Cataloged Diptera of America north of Mexico, including more than 16,000 species
1966 Published extensive annotated list of generic names of scale insects
1971 Published first fascicle of multiple-volume work on moths of America north of Mexico; it will include line drawings, color photographs, keys, and descriptions of over 15,000 species
1972 Established computer program for catalog of Hymenoptera of America north of Mexico
1975 Formulated program for computerization of catalog on Coleoptera of America north of Mexico
1975 Revised Epilachninae of Western Hemisphere, including 288 species and several pests, such as Mexican bean beetle and squash beetle
1976 Published book on sphecid wasps of the world, including 7,634 species
1976 Revised lady beetle tribe Scymnini, including many important predators

Selected Publications

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U.S. NATIONAL POLLINATING INSECTS COLLECTION

Bee Biology and Systematic Laboratory

By FRANK D. PARKER

Location: Rm. 261, NRB, UMC 53, Utah State University, Logan, Utah 84322
Loans: To recognized institutions and scientists
Associated libraries: 11,000 reprints
Number of accessions: 3,500 species of bees (worldwide) and 1,000 species of wasps, flies, butterflies, and beetles in 600 museum drawers (210,000 specimens)
Types: Few paratypes
Curator: Frank D. Parker, (801)-752-4100, ext. 7493, or FTS 586-7493

Background

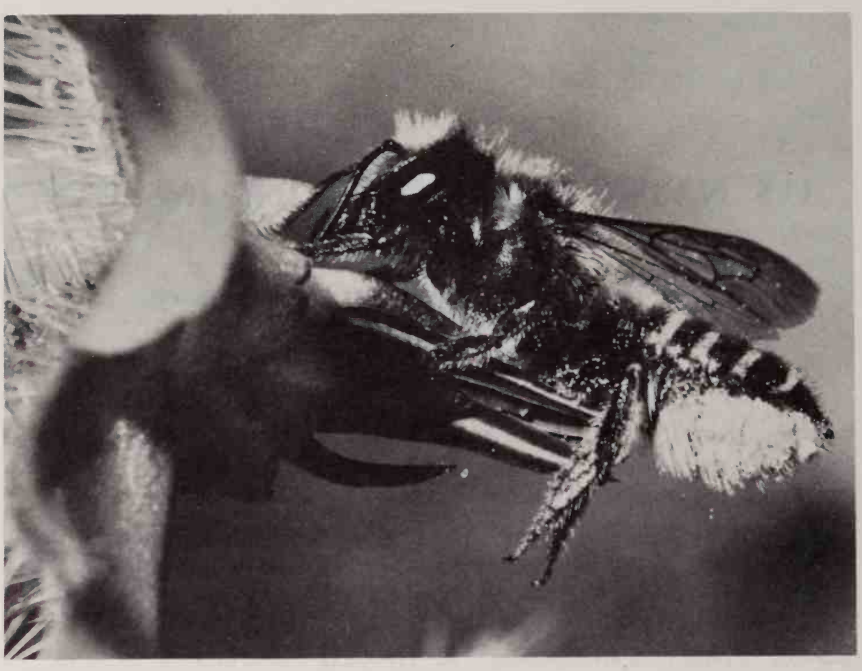
The U.S. National Pollinating Insects Collection provides the basis for both systematic and biological studies on pollinating insects from many parts of the world. The collection was started in 1947 by G. E. Bohart. It has expanded rapidly with acquisitions of biological material and exchanges with other institutions. Bohart has contributed many specimens, as have P. F. Torchio, W. P. Nye, and F. D. Parker. Bohart is now a Federal collaborator and he and Parker have been active in managing the collection and adding new accessions. Holotypes are deposited in museums that have major type collections.

Service Identification

Each year many requests for identifications of pollinating insects are received from research scientists, bee systematists, graduate students, State and county farm advisers and extension agents, apiculturists, bee breeders, seed growers, and others. Also, many taxpayers request bee information, including the analysis and causes of bee stock losses due to parasites or predators.

Research

The Bee Biology and Systematic Laboratory is responsible for studies of pollinating insects, primarily bees, including their adult and immature systematics, biology, role in plant pollination, and use as crop pollinators (fig. 1). Also, associated predators and parasites of pollinators are studied. Research



PN-5477

FIGURE 1.—Native leafcutter bee *Megachile relativa* collecting pollen from a borage flower.

on candidate pollinators introduced from foreign countries is one of the important programs, including specimen documentation of all new introductions deposited in the Pollinating Insects Collection. This collection is the basic tool for much of the research carried on at this laboratory (fig. 2).

Selected Achievements

1953 Domesticated first native bee, resulting in over twentyfold increase in alfalfa seed production

1960 Assisted in developing multimillion dollar leafcutter bee industry

1973 Developed method to control leafcutter bee parasite, with savings of millions of dollars to alfalfa seed industry

1975 Developed blue orchard bee *Osmia lignaria,* which augments honey bee pollination of orchard crops

Selected Publications

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PN-5478

FIGURE 2.—Entomologists studying bee specimens from collection cabinet.

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U.S. RANGELAND GRASSHOPPER COLLECTION

Rangeland Insect Laboratory

By GEORGE B. HEWITT

Location: Montana State University, Bozeman, Mont. 59715
Loans: To recognized institutions and scientists
Associated libraries: 170 reprints
Number of accessions: 9,000 specimens, 270 species
Types: 2 paratypes
Curator: George B. Hewitt, (406)-994-3344

Background

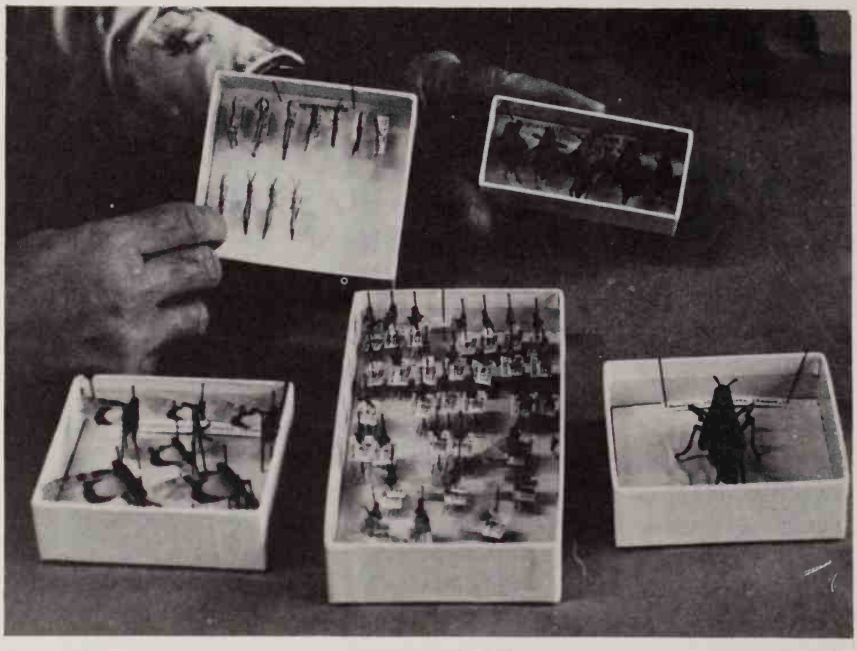
The U.S. Rangeland Grasshopper Collection contains shorthorned grasshopper species from different habitats of the Western States (fig. 1). The collection was started in the early 1920's by Robert L. Shotwell and Steward Lockwood, who were employed by the Bureau of Entomology, USDA, in Billings, Mont. Most of the specimens were obtained in early surveys throughout the United States by government entomologists. In 1930, the collection was moved to Montana State University. John R. Parker was in charge of the collection, and the laboratory became known as the Grasshopper and Mormon Cricket Laboratory. During this time, Fred Skoog and Louis Spain were the curators, and many specimens were added to the collection. In 1961, when the collection was moved to another building at the university, Frank Cowan was in charge of the laboratory. George Hewitt has been responsible for the collection since 1970. It is housed in the Rangeland Insect Laboratory and Jerry Onsager is the research leader in charge.

Service Identification

Identifications are made for Federal, State, and private research scientists and for others concerned with pest problems. The collection has been used to assist scientists in locating potential collecting sites for species used in research, and it provides specimens for taxonomic revisions. Information has been made available to movie producers for filming pictures with grasshoppers.

Research

The collection has been used to assist researchers in testing and establishing dosages for insecticides, testing and describing viruses and protozoans for the



PN-5479

FIGURE 1.—Various species of western rangeland grasshoppers.

biological control of grasshoppers, determining life histories, food preferences, distribution of many species, screening foreign and native parasites as possible control agents, and determining how rangeland renovations affect grasshopper abundance. At present the collection is used for field testing the protozoan *Nosema locustae,* determining forage losses caused by rangeland grasshoppers, screening insecticides, and evaluating foreign and local parasites as grasshopper control agents.

Selected Publications

Hewitt, G. B., and Barr, W. F. 1967. The banded-wing grasshoppers of Idaho (Orthoptera: Oedipodinae). Idaho Agr. Res. Bul. 72, 64 pp.

Hewitt, G. B., Huddleston, E. W., Lavigne, R. J., and others. 1974. Rangeland entomology. Soc. Range Mangt. Range Sci. Ser. No. 2, 127 pp. Denver, Colo.

Hewitt, G. B., and Skoog, F. E. 1970. *Melanoplus lanthanus* (Orthoptera:Acrididae) a new Montana grasshopper of the *M. artemisiae* group. Ent. Soc. Amer. Ann. 63: 1245–1248.

Rees, N. E. 1973. Arthropod and nematode parasites, parasitoides, and predators of Acrididae in America north of Mexico. U.S. Dept. Agr. Tech. Bul. 1460, 288 pp.

NEMATODES

USDA NEMATODE COLLECTION

Nematology Laboratory
Plant Protection Institute

By A. MORGAN GOLDEN

Location: Rm. 159, Bldg. 011A, BARC-West, Beltsville, Md. 20705
Loans: To recognized scientists and institutions
Associated libraries: 15,000 reprints and volumes
Number of accessions: 19,000 permanent slides and vials, 11,000 species
Types: 800 species
Curators: A. Morgan Golden, curator-in-charge, (301)-344-3666
Systematics, morphology, and identification of plant nematodes
William Friedman, (301)-344-3005
(Animal and Plant Health Inspection Service)
Identification of plant nematodes
William R. Nickle, (301)-344-3064
Systematics, morphology, and identification of insect nematodes

Background

The USDA Nematode Collection, one of the largest and most valuable in existence, is widely used by research scientists in the United States and many other countries to resolve various taxonomic and nomenclatural problems and to advance and stabilize nematode systematics. The collection facilitates identifications and provides substantial data on nematode hosts, occurrence, and distribution on a worldwide basis.

From 1908 until his death in 1932, N. A. Cobb did extensive taxonomic research on plant, soil, freshwater, and marine nematodes. In 1918, he was joined by G. Steiner, who made major contributions in taxonomy, including insect parasites, until his retirement in 1956. Concurrently, Gerald Thorne joined USDA in Utah and for the next 38 years made major contributions in nematode taxonomy, almost exclusively in plant and soil forms. Other USDA scientists who have made significant contributions in taxonomy and other areas of nematology in the Washington area during the 1920's and 1930's include B. G. Chitwood, J. R. Christie, and A. L. Taylor.

Most of the specimens used by these earlier workers were retained as individual collections within the agency rather than in an organized, unified

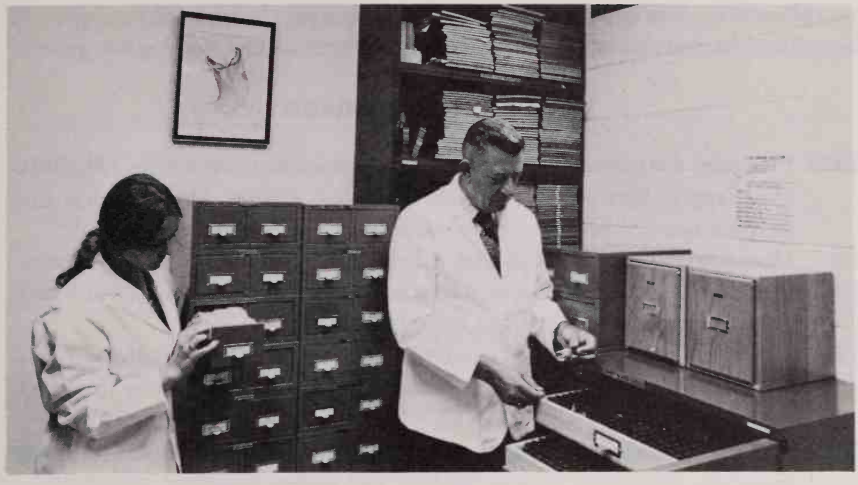
system. Unfortunately over the years many valuable specimens deteriorated and others were misplaced or their records lost. Extant specimens are being salvaged and incorporated into the USDA Nematode Collection.

Fortunately the Gerald Thorne collection, developed by Mr. Thorne in Utah between 1918 and 1956, was well organized, well kept, and now forms an important segment of the present collection.

The USDA Nematode Collection was officially established by A. Morgan Golden in 1960 shortly after initiation of the current nematode taxonomy program. The collection was organized so that records of all specimens, which are on numbered slides or in vials, could be filed according to genus, species, host, and origin (figs. 1 and 2). This is an open-ended system that will permit easy conversion to computerization in the future and that allows ready retrieval

PN-5480

FIGURE 1.—Nematologist checking label on slide-mounted nematode.



PN-5481

FIGURE 2.—Curator removing vial containing nematodes while nematologist is checking records.

of specimens as well as data on nematode hosts, occurrence, and distribution. Although most of the specimens are plant and soil nematodes, there are insect parasites and free-living soil, freshwater, and marine forms. Most specimens, including all types with pertinent records, are kept in fireproof safes.

The constituent divisions of the USDA Nematode Collection are *type collection*—designated types; *general collection*—species from many different hosts and areas, especially useful for comparison and reference purposes, variation studies, and so forth; *mass collection*—reservoir for problematical and undescribed taxa, most of which will be studied and described as groups are revised; *demonstration collection*—shows symptoms and effects of various kinds of nematodes on a wide range of host plants; *Gerald Thorne collection*—4,000 slides of important plant and soil species and higher taxa; *Steiner mermithid collection*—more than 3,400 slides of nematode (mermithid) parasites of insects, with many original types; and *sample records division*—data on all samples and nematodes examined.

Service Identification

Each year about 400 samples are processed primarily from Federal and State agencies and USDA, State, and foreign scientists. Identifications are used for regulatory, control, and research purposes, including development of resistant crop cultivars. This service provides needed information on nematode hosts, occurrence, and distribution and can uncover undescribed taxa, new plant disease potentials, and new candidate nematodes for biocontrol against insects.

Research

The current staff of two ARS nematode systematists places major emphasis on taxonomy, morphology, and identification of important groups of plant parasitic forms and of nematode parasites and associates of insects. New

morphometric data and techniques, such as scanning electron microscopy, will be utilized in characterizing and clarifying various species and higher groups.

Selected Achievements

1949 Produced first modern classification of root-knot nematodes (*Meloidogyne* spp.), providing a sound basis for species identification and development of resistant crop varieties for individual species

1967 Monographed Sphaerulariidae, a family of insect parasitic nematodes

1967 Established Encholaimoidea, a new monotypic superfamily phylogenetically linking soil and marine nematodes

1969 Identified and described rice root-knot nematode (*Meloidogyne graminicola* Golden and Birchfield), a major new pest of rice in several countries

1970 Revised Aphelenchoidea, a nematode superfamily containing plant parasites, predators, fungus feeders, and insect parasites

1971 Revised order Tylenchida, containing majority of plant nematodes

1972 Revised insect parasitic nematode family Mermithidae, presenting new information on life cycles and host ranges

1974 Documented first occurrence in United States of oat cyst nematode (*Heterodera avenae* Wollenweber), a major worldwide pest of cereals; it is now under survey, regulation, and research

Selected Publications

Chitwood, B. G. 1949. Root-knot nematodes. Pt. I. A revision of the genus *Meloidogyne* Goeldi, 1887. Helminthol. Soc. Wash. Proc. 16: 90–104.

Golden, A. M. 1971. Classification of the genera and higher categories of the order Tylenchida (Nematoda). *In* Zuckerman, B. M., Mai, W. F., and Rohde, R. A., eds., Plant Parasitic Nematodes, v. 1, pp. 191–232. Academic Press Inc., New York.

Golden, A. M., and Ellington, D. M. S. 1972. Redescription of *Heterodera rostochiensis* (Nematoda:Heteroderidae) with a key and notes on closely related species. Helminthol. Soc. Wash. Proc. 39: 64–78.

Golden, A. M., and Jensen, H. J. 1974. *Nacobbodera chitwoodi,* n. gen., n. sp. (Nematoda:Nacobbidae) on Douglas fir in Oregon. Nematol. Jour. 6: 30–37.

Golden, A. M., and Murphy, D. G. 1967. Encholaimoidea (Nematoda:Dorylaimida), a new superfamily representing dorylaimid specimens with cephalic setae. Helminthol. Soc. Wash. Proc. 34: 94–98.

Golden, A. M., and Raski, D. J. 1977. *Heterodera thornei* n. sp. (Nematoda:Heteroderidae) and a review of related species. Nematol. Jour. 9 [In press.]

Nickle, W. R. 1967. On the classification of the insect parasitic nematodes of the Sphaerulariidae Lubbock, 1861 (Tylenchoidea:Nematoda). Helminthol. Soc. Wash. Proc. 34: 72–94.

Nickle, W. R. 1970. A taxonomic review of the genera of the Aphelenchoidea (Fuchs 1937) Thorne, 1949 (Nematoda:Tylenchida). Nematol. Jour. 2: 375–392.

Nickle, W. R. 1972. A contribution to our knowledge of the Mermithidae (Nematoda). Nematol. Jour. 4: 113–146.

Nickle, W. R. 1973. Identification of insect parasitic nematodes—a review. Expt. Parasitol. 33: 303–317.

Nickle, W. R. 1974. Nematode infections. *In* Cantwell, G. E., ed., Insect Diseases, v. 2, chap. 7, pp. 327–376. Marcel Dekker, Inc., New York.

PLANTS

ARS COTTON HERBARIUM

Cotton Genetics Research

By PAUL A. FRYXELL

Location: Rm. 112 and 112A, Agronomy Field Laboratory, Texas A&M University, College Station, Tex. 77843
Loans: To recognized institutions and scientists
Associated libraries: 600 volumes
Number of accessions: 7,000 specimens
Types: 70 types plus photographs of over 1,300 types
Curator: Paul A. Fryxell, (713)-846-8821, ext. 257, or FTS 527-1257

Background

The ARS Cotton Herbarium originated in 1965, when the Agricultural Research Service appointed Paul A. Fryxell as its curator. The principal purpose of the herbarium is to support and to document taxonomic research on *Gossypium* and related plants of the family Malvaceae.

Service Identification

Each year the curator identifies several hundred specimens of Malvaceae submitted by scientists and herbaria in this country and abroad. Nomenclatural and other taxonomic questions pertaining to cotton are directed to him by various colleagues, as well as requests for identification of host plants of cotton insects.

Research

Some of the research on *Gossypium* and other malvaceous genera is in collaboration with ARS and State entomologists concerned with the taxonomy of alternate host plants of insects damaging cotton and with cytogeneticists working on cotton and related plants. Several graduate students at Texas A&M University are also conducting research studies based on the collection.

The research program includes revisionary studies of selected genera or other taxonomic groups, nomenclatural analyses, and evolutionary studies, as well as greenhouse studies and considerable field work in the Tropics. Research procedures involve comparative morphology, comparative phytochemistry,

comparative phytogeography, cytology, palynology, and artificial hybridization. The scanning electron microscope is one of the instruments used.

Selected Achievements

1967 Recognized taxonomic position of *Hampea,* a genus of Central American trees, which led to discovery of its significance as alternate host of boll weevil (*Anthonomus grandis*) and other important cotton insects

1976 Revised various malvaceous genera to add to taxonomic knowledge and to place *Gossypium* in context within the family so as to better perceive its potentialities

1976 Sharpened our taxonomic understanding of *Gossypium,* with studies of its evolution, description of new species, typification, and revised classification, and provided a frame of reference for communication in other disciplines about *Gossypium* and a means of information storage and retrieval

Selected Publications

Fryxell, P. A. 1965. Stages in the evolution of *Gossypium* L. Advancing Frontiers Plant Sci. 10: 31–56.

Fryxell, P. A. 1968. The typification and application of the Linnaean binomials in *Gossypium.* Brittonia 20: 378–386.

Fryxell, P. A. 1968. A redefinition of the tribe Gossypieae. Bot. Gaz. 129: 296–308.

Fryxell, P. A. 1969. The genus *Hampea* (Malvaceae). Brittonia 21: 359–396.

Fryxell, P. A. 1971. Phenetic analysis and the phylogeny of the diploid species of *Gossypium* L. (Malvaceae). Evolution 25: 554–562.

Fryxell, P. A. 1976. A nomenclator of *Gossypium* - the botanical names of cotton. U.S. Dept. Agr. Tech. Bul. 1491, 114 pp.

INTER-REGIONAL POTATO INTRODUCTION HERBARIUM

Inter-Regional Potato Introduction Project

By R. E. HANNEMAN, JR.

Location: Peninsular Branch Experiment Station, University of Wisconsin, Sturgeon Bay, Wis. 54235
Loans: To recognized institutions and scientists
Associated libraries: Very limited
Number of accessions: Approximately 3,630 accessions of nearly 90 species
Types: None
Curators: R. E. Hanneman, Jr., curator-in-charge, (608)-262-1492
R. W. Ross

Background

The Inter-Regional Potato Introduction Herbarium, established in the early 1950's, houses voucher specimens of original introductions of wild and cultivated tuber-bearing *Solanum* species. As part of the national germ plasm system, the objectives of the Inter-Regional Potato Introduction Project (IR-1) are to introduce, preserve, classify, preliminarily evaluate, and distribute wild and cultivated tuber-bearing *Solanum* species. The IR-1 project gained a worldwide reputation for service and reliability under the leadership of R. W. Hougas from 1948 to 1962. P. R. Rowe was leader from 1963 to 1973, and R. E. Hanneman, Jr., succeeded him in 1974.

Service Identification and Research

Unlike other ARS collections or herbaria, the personnel of this herbarium are seldom involved in service identifications and taxonomic research. The herbarium is used by visiting scientists and students, who report their research independently.

U.S. LIVING COLLECTION OF PERENNIAL TRITICEAE GRASSES

Forage and Range Project
Crops Research Laboratory

By DOUGLAS R. DEWEY

Location: Rm. 206, Crops Research Laboratory, Utah State University, Logan, Utah 84322
Loans: Viable seed and living clonal material are available for exchange with recognized institutions and scientists
Associated libraries: None
Number of accessions: 2,000
Types: None
Curator: Douglas R. Dewey, (801)–752–4100, ext. 7400, or FTS 586–7400

Background

The U.S. Living Collection of Perennial Triticeae Grasses is the largest of its kind in the world and contains representative collections of about two-thirds of the approximately 200 perennial species of *Agropyron, Elymus, Sitanion,* and *Hordeum.* In addition, it includes more than 100 species-hybrids and 50 colchicine-induced amphiploid hybrids. The collection is dynamic, and its content changes each year. Living plants and viable seeds are maintained of all species and amphiploids.

This collection is an outgrowth of a cytogenetic project begun in 1962 on perennial Triticeae grasses by Douglas R. Dewey. Germ plasm was obtained of all Triticeae grasses maintained at regional plant introduction stations. Beginning in 1969, the collection was expanded with seeds obtained directly from foreign scientists via the International Triticeae Cooperative, which was organized by Dewey. It consists of 14 cytogeneticists and biosystematists from 9 countries with an interest in perennial Triticeae grasses. Seed exchange is a major function of the cooperative. The most recent additions are samples obtained by Dewey in 1972 from Iran and by K. H. Asay and Norman Hooven in 1975 from the Western United States. Efforts to acquire additional collections from all parts of the world are continuing.

Artificially synthesized taxa constitute a significant segment of the collection. More than 50 incipient species have been generated since 1965 through interspecific and intergeneric hybridization followed by induced amphiploidy. Controlled introgressive hybridization between species via

partially fertile F_1 hybrids can give rise to new taxa below the species level. New hybrids and amphiploids are being added each year.

Service Identification

The staff is able to determine the putative parents of suspected natural interspecific and intergeneric hybrids in the Triticeae. It can also identify perennial Triticeae grass species from either dried specimens or seeds. A few requests for species identification are filled each year for State and Federal agencies and for individuals.

Research

The U.S. Living Collection of Perennial Triticeae Grasses is used to define genomic and phylogenetic relationships among component species. The species are used in crosses to make interspecific and intergeneric hybrids. Chromosome pairing is observed in the species and in their hybrids to ascertain their genomic relationships (fig. 1). The long-term goals of the research

PN-5482

FIGURE 1.—Technician studying chromosome pairing. Chromosome photographs on wall.

program are to determine the genome constitution of all perennial species in the Triticeae and to develop a taxonomic classification based on phylogeny and biological relationships. The first goal is about two-thirds realized. A monograph and complete taxonomic revision should be forthcoming by the late 1980's.

The second aspect of the research program involves synthesis of new grass species through chromosome doubling of sterile F_1 hybrids or introgressive hybridization via partially fertile F_1 hybrids. More than 50 colchicine-induced amphiploids have been synthesized. Although fertility is immediately restored by chromosome doubling, it declines in advanced generations. Causes of its decline are being studied. Most newly synthesized species are inferior to naturally occurring species; however, a few show promise as new forage grasses. Introgressive hybridization appears to be a more promising means of developing vigorous, fertile, stable new species than does induced amphiploidy. Advanced generation hybrids between bluebunch wheatgrass (*Agropyron spicatum*) and quackgrass (*Agropyron repens*) are fully fertile, are cytologically stable, and contain the desirable forage characteristics of both species. Their introgressant forms are easily distinguished from both parent species. However, introgression usually results in the transfer of less obvious characteristics from one species to another, and often a low-power microscope is required to verify the transfer (fig. 2).

PN-5483

FIGURE 2.—Technician examining detailed morphological characteristics in advanced generation hybrid.

Selected Achievements

1969 Demonstrated that all crested wheatgrasses (*Agropyron* spp.) are built on same basic genome

1970 Determined that more than 50 *Agropyron, Elymus,* and *Sitanion* species have a common phylogeny

1972 Discovered that diploid *Elymus junceus* is source of genome in at least 25 polyploid *Elymus* spp.

1974 Outlined taxonomic realinement that reflects biological relationships among *Agropyron, Elymus,* and *Sitanion*

1975 Established parentage and mode of origin of *Agropyron albicans, A. leptourum,* and *A. smithii*

1976 Derived new economically useful grass species from hybrids between *Agropyron repens* and *A. spicatum*

Selected Publications

Dewey, D. R. 1964. Natural and synthetic hybrids of *Agropyron spicatum* X *Sitanion hystrix.* Torrey Bot. Club Bul. 91: 396–405.

Dewey, D. R. 1970. Genome relations among diploid *Elymus junceus* and certain tetraploid and octoploid *Elymus* species. Amer. Jour. Bot. 57: 633–639.

Dewey, D. R. 1971. Synthetic hybrids of *Hordeum bogdanii* with *Elymus canadensis* and *Sitanion hystrix.* Amer. Jour. Bot. 58: 902–908.

Dewey, D. R. 1972. The origin of *Agropyron leptourum.* Amer. Jour. Bot. 59: 836–842.

Dewey, D. R. 1974. Cytogenetics of *Elymus sibiricus* and its hybrids with *Agropyron tauri, Elymus canadensis,* and *Agropyron canium.* Bot. Gaz. 135: 80–87.

Dewey, D. R. 1976. Derivation of a new forage grass from *Agropyron repens* X *Agropyron spicatum* hybrids. Crop Sci. 16 (2): 175–180.

U.S. NATIONAL ARBORETUM HERBARIUM

U.S. National Arboretum

By FREDERICK G. MEYER

Location: Washington, D.C. 20002
Loans: To recognized research institutions and scientists
Associated libraries: 6,000 volumes, 5,000 reprints
Number of specimens: 400,000
Types: 2,000
Curators: Frederick G. Meyer, curator-in-charge, (202)–399–5400
Cultivated trees and shrubs of the Southeastern United States, *Koelreuteria, Coffea, Valeriana,* and plants in archeological sites of Pompeii and Herculaneum

Theodore R. Dudley
Ilex, Viburnum, Cruciferae, *Cotoneaster,* dwarf conifers, and flora of Staten Island, Argentina

Ronald M. Jefferson
Malus (flowering crabapples), *Prunus* (flowering cherries), and documentation of plant genetic resources

Peter M. Mazzeo
Betulaceae of Virginia, plants of the Blue Ridge Mountains, native and cultivated conifers, and cultivated trees and shrubs of the Southeastern United States

Background

The U.S. National Arboretum Herbarium is a facility for research on the systematics, nomenclature, and history of cultivated plants. Worldwide in scope, it serves as a national repository for voucher material of wild and cultivated progenitors of plants related to agriculture, including food, forage and industrial plants, ornamental and drug plants, weeds, and forest trees. The collection also contains named cultivars, hybrids, and other elite materials covering a wide diversity of cultivated plant groups from azaleas to zoysia, beets to magnolias, lilies to economic legumes, cotton, wheat, alfalfa, carrots, holly, crapemyrtle, African violets, and a host of others.

The earliest herbarium of the Department of Agriculture, but not the present one, dates from 1868, when the U.S. National Herbarium of the Smithsonian Institution was transferred to the Department of Agriculture. During the 1880's and 1890's, the herbarium was staffed by George Vasey, William E. Safford, and Frederick V. Coville, who were the principal workers at

that time. On July 1, 1896, the herbarium was returned to the official custody of the Smithsonian Institution under Frederick V. Coville, then chief botanist of the Department of Agriculture and the honorary curator of the National Herbarium until his death in 1937. Between 1896 and 1934 the Department of Agriculture was without an official herbarium. Nevertheless during these 38 years, various individuals with the Department began to prepare herbarium specimens of nursery plants, as well as material of plant introductions sent to the United States from foreign countries under the Office of Foreign Seed and Plant Introduction, organized in 1898. These employees included P. L. Ricker, David Fairchild, O. F. Cook, W. T. Swingle, W. F. Wight, C. V. Piper, C. D. Marsh, and D. A. Bissett.

One of the aims of the herbarium has always been to document the germ plasm materials sent to this country by USDA plant explorers as a permanent legacy on the history and development of American agriculture. These early materials formed the basis of the present herbarium of cultivated plants and consisted of material from many parts of the world, sent by N. E. Hansen and M. A. Carleton from Russia, by the worldwide contacts of W. T. Swingle, by J. N. Rose from Mexico, by David Fairchild from many parts of the Tropics, by F. N. Meyer from China, Turkestan, and the Near East, by P. H. Dorsett from China and Japan, by Wilson Popenoe from Latin America, and from many other sources. Among more recent plant explorers whose collections are represented in the herbarium are D. S. Correll (Latin America), W. Koelz (Iran, Afghanistan, India), H. S. Gentry (Mexico, Middle East), J. L. Creech (Japan), and F. G. Meyer (Europe, Ethiopia).

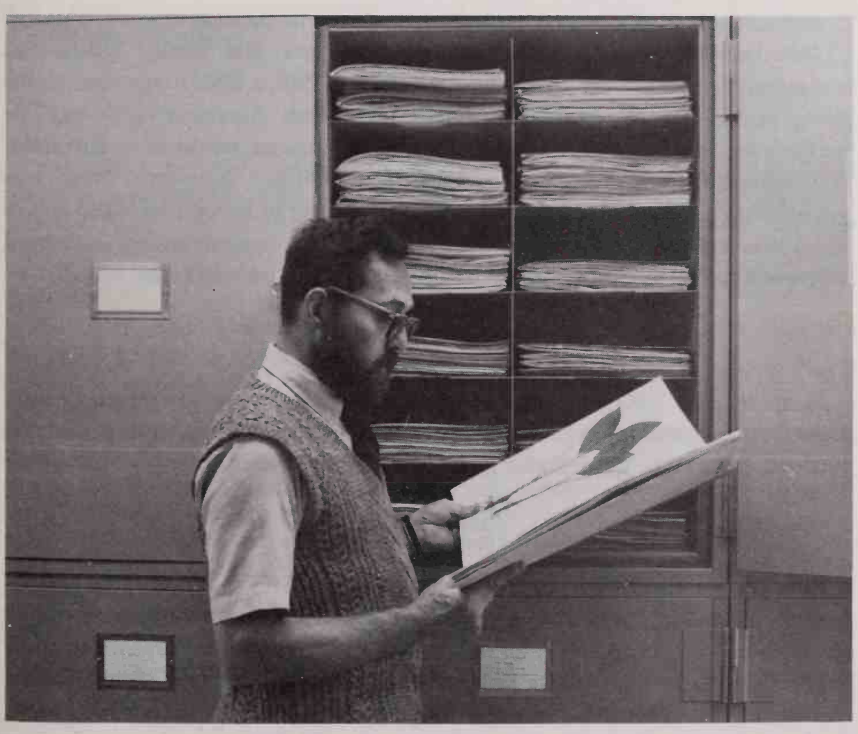
The present herbarium of the U.S. National Arboretum was established in 1934 by B. Y. Morrison, then principal horticulturist, Division of Plant Introduction and Exploration, Department of Agriculture. For many years Morrison was chief of the Foreign Seed and Plant Introduction Office and first director of the National Arboretum. Under his inspired leadership the herbarium grew rapidly in the 1930's and 1940's. From its original quarters in the old agriculture building in downtown Washington, D.C., the herbarium was moved to the Department's research facility at Beltsville, Md., in the late 1930's. In 1951, the herbarium officially became part of the U.S. National Arboretum. In 1959, the herbarium was moved from Beltsville to a temporary storage area at the National Arboretum. Permanent quarters were established in the two-floor wing of the new Arboretum Administration Building in 1964. From its founding in 1934, the principal curators of the herbarium have been W. Andrew Archer to 1959, Gabriel Edwin from 1959 to 1963, and Frederick G. Meyer from 1963 to the present.

During World War II, the herbarium had a staff of 17 botanists, many of whom were in South America collecting wild rubber (*Hevea*) and quinine (*Cinchona*) for the war effort. Botanists actively associated with the herbarium at that time included S. F. Blake, W. Andrew Archer, F. R. Fosberg, Joseph Ewan, Rogers McVaugh, F. J. Hermann, and C. H. Muller.

The herbarium is worldwide in its coverage of both wild and cultivated plants. Overall it contains about 400,000 specimens (figs. 1 and 2). The

PN-5484

FIGURE 1.—Curator sorting plant specimens prior to filing in herbarium.



PN-5485

FIGURE 2.—Curator with herbarium specimens.

reference material of cultivated plants numbers between 50,000 and 60,000 specimens. The general herbarium contains an extensive reference collection of the native flora of the United States and Canada and also material from Japan, China, South America, Africa, Australia, and other areas.

A major acquisition was the 19th century herbarium of Isaac C. Martindale, purchased in 1964 from the Philadelphia College of Pharmacy and Science. The Martindale herbarium contains about 85,000 specimens and is represented by over 700 collectors. The collection is rich in historic material, including types, of the 19th century from many parts of the world, particularly North America and Europe. U.S. collectors represented include C. F. and R. M. Austin, M. E. Bebb, H. N. Bolander, Wm. M. Canby, E. L. Greene, Marcus E. Jones, F. Lindheimer, E. J. Palmer, S. B. Parish, C. F. Parker, C. C. Parry, Zina Pitcher, C. G. Pringle, J. H. Redfield, J. Reverchon, J. T. Rothrock, and Ferdinand Rugel. The Mexican collections of C. G. Pringle and E. J. Palmer are fairly extensive.

Material from Europe is represented by a large number of collectors, many well known, including G. Gaudin, who wrote a flora of Switzerland in the 1830's, John Stuart Mill, famous logician, economist, and sometimes botanist, W. D. J. Koch, J. E. Planchon, A. de St. Hilaire, C. F. Hochstetter, and George Bentham. A few European collections date from the late 18th century. Also represented is a fine set of specimens collected by E. G. Post from the Middle East and another by C. F. Cheeseman from New Zealand, both of which formed the basis of a flora of their respective regions.

The Carlton R. Ball willow collection, acquired by bequest in 1958, contains 25,000 herbarium specimens, plus 700 reprints and books, notes, and bibliographic files on the genus *Salix*. Carlton R. Ball, a USDA agronomist for many years, was the leading authority on North American willows. The herbarium also contains material donated by various workers to document taxonomic research projects, including *Acer, Manihot, Juniperus, Pinus,* and grass hybrids. The Macay nut collection, consisting of several hundred jars of nuts, was started in the early 20th century and represents an important reference collection of nut varieties grown in the United States.

Service Identification

Most of the 5,000 service identifications each year are requested by government agencies, experiment stations, educational institutions, botanic gardens, embassies, garden clubs, and the general public.

Research

Research at the U.S. National Arboretum Herbarium is centered on the nomenclature and taxonomy of cultivated plants. Research topics normally apply to plant groups, some of which are of economic importance to man. From 1940 to 1965, a major project was the multiauthored "Contributions Toward a Flora of Nevada," issued in 50 parts, under the general direction of W. Andrew Archer. Research projects have covered *Rhododendron* (subgenus *Azalea*), *Coffea, Ilex, Magnolia, Viburnum, Malus, Betula,* and *Koelreuteria.*

Ongoing research projects include taxonomic investigations in *Ilex, Viburnum, Betula,* and *Prunus*. Underway also are projects on the identification of archeological plant material in the ancient cities of Pompeii and Herculaneum in Italy and another on the identification and documentation of cultivated trees and shrubs of the Southeastern United States.

Selected Achievements

1941 Issued first volume of geographical guide to floras of the world
1942 Published monograph on Central American oak trees
1953 Published descriptive list of Glenn Dale azalea cultivars, a new class of hardy azaleas
1961 Issued first descriptive list of bamboos cultivated in the United States
1961 Issued second volume of geographical guide to floras of the world
1962 Monographed soybean genus *Glycine*
1965 Terminated series on contributions toward flora of Nevada, issued in 50 parts
1965 Published first flora of Japan in English
1976 Monographed genus *Koelreuteria*
1976 Reported discovery of *Betula uber,* a species from Virginia thought to be extinct
1977 Contributed comprehensive account on flora of Staten Island, Tierra del Fuego, Argentina

Selected Publications

Archer, W. A., and others. 1940–65. Contributions toward a flora of Nevada. 50 pts., 1,945 pp. U.S. Dept. Agr., Div. Plant Exploration and Introd., Washington, D.C. [Processed.]

Archer, W. A. 1945. Collecting data and specimens for study of economic plants. U.S. Dept. Agr. Misc. Pub. 568, 52 pp.

Archer, W. A. 1950. New plastic aid in mounting herbarium specimens. Rhodora 52: 298–299.

Blake, S. F. 1961. Geographical guide to floras of the world. Pt. II. U.S. Dept. Agr. Misc. Pub. 797, 742 pp.

Blake, S. F., and Atwood, A. C. 1942. Geographical guide to floras of the world. Pt. I. U.S. Dept. Agr. Misc. Pub. 401, 336 pp.

Correll, D. S. 1952. Section Tuberarium of the genus *Solanum* of North America and Central America. U.S. Dept. Agr. Monog. 11, 243 pp.

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SEEDS

U.S. NATIONAL SEED HERBARIUM

Plant Taxonomy Laboratory
Plant Genetics and Germplasm Institute

By CHARLES G. GUNN

Location: Rm. 238, Bldg. 001, BARC-West, Beltsville, Md. 20705
Loans: To recognized institutions and scientists
Associated libraries: 3,000 volumes
Number of accessions: 90,000 seed-fruit samples, 25,000 species
Types: None
Curator: Charles R. Gunn, (301)-344-3367

Background

The U.S. National Seed Herbarium is the world's largest taxonomic seed collection. Its curator provides research material and rapid identification of isolated seeds and fruits of economically important plants. Viable seed lots of important crop species are stored in the ARS Seed Germplasm Collection, National Seed Storage Laboratory, Fort Collins, Colo.

Since its inception, the U.S. National Seed Herbarium (sponsoring-agency name changes notwithstanding) is closely associated with the USDA worldwide Plant Introduction (PI) program. This program has introduced more than 418,000 accessions, most of them seeds. The first recorded PI, for which a seed sample was kept, is a cultivar of cabbage received from Russia in February 1898 (PI 3). Apparently PI samples were kept in a temporary fashion until 1908, when Homer C. Skeels, Office of Taxonomic and Range Investigations, U.S. Bureau of Plant Industry, established the seed herbarium. He continued to curate and to expand it until his death in 1934. Paul Russell enlarged it into a major taxonomic collection until his retirement in 1960. He continued as "curator" until his death in April 1964. Between 1960 and 1964, Eugene Griffith was generally responsible for managing the herbarium and adding new accessions. Charles R. Gunn, the first professionally trained seed taxonomist to curate the herbarium, has been curator since 1965.

Prior to 1965, the emphasis was on making service identifications and accessioning samples. During 1965, the emphasis was expanded to include research and documentation as well as service identifications and accessioning. With this change, the seed herbarium was converted from a museum-type collection into a research collection. The container series of seed-fruit sizes

were reduced from 6 to 2, all samples were checked, and the number of herbarium cases increased to 34 (fig. 1). Procedures for documenting the seed-fruit samples were established with the advent of a card control system. Many samples are vouchered by herbarium specimens deposited in the U.S. National Herbarium (Smithsonian Institution) and the U.S. National Arboretum Herbarium (ARS).

The Plant Taxonomy Laboratory is also responsible for vascular plant nomenclature for the Agricultural Research Service as well as for the identification of vascular plants, especially crops from the Plant Introduction program and weeds. Edward E. Terrell handles nomenclature as well as the identification of grasses and other nonleguminous plants. In addition to his seed-fruit identifications, Charles R. Gunn identifies legume plants. James A.

PN-5486

FIGURE 1.—Box with 88 seed-fruit samples in 7- by 1.5-cm glass vials (foreground); box with larger seeds and fruits in gusseted polyethylene bags (background).

Duke, laboratory chief, is constructing a computer data base, which includes ecological, geographical, nomenclatural, and taxonomic data for economically important plants. Some of these data will be used in a manual of crop legumes.

Service Identification

Most of the 1,000 service identifications each year are derived from PI accessions. Identifications are also made for inspectors of the Animal and Plant Health Inspection Service, ARS scientists, the National Seed Testing Standardization Laboratory, the Soil Conservation Service, the Smithsonian Institution, U.S. Customs and other law enforcement agencies, State seed laboratories, and foreign departments of agriculture. Taxpayers often ask for identification of poisonous seeds and fruits.

Research

Until 1973, research on seed-fruit identifications usually was based on data collected from traditional morphological studies, which resulted in publications. An innovative method of seed identification using a conversational computer has been developed for service identifications and research. This system is functional for identifying isolated seeds and fruits of North American papaveraceous genera and species and worldwide papaveraceous genera. The computer is being data banked for identification of isolated seeds and fruits of the 680-genus legume family (Fabaceae).

Properly prepared documentation sheets facilitate the recording and numeric coding of seed-fruit data, which are data banked as dichotomous, multistate, or quantitative observations (fig. 2). The data bank may be subdivided into matrices, which correspond to the rank of the studied taxa. Four major tested data-processing programs are used to solve taxonomic problems. The compare program (CMPARE) compares taxa within a matrix. A description of each taxon is generated by the describe program (DSCRBE). Identifications may be made using the identification program (IDENT4). A key program (KEY3) issues indented dichotomous diagnostic keys. Other programs are available. The parameter of this system is being expanded with data gathered by such computer-compatible equipment as the scanning electron microscope, spectrophotometer, and soft X-ray machine, and by chemical analysis systems. Feeding data directly into a properly programed computer could mechanize the identification of isolated seeds and fruits.

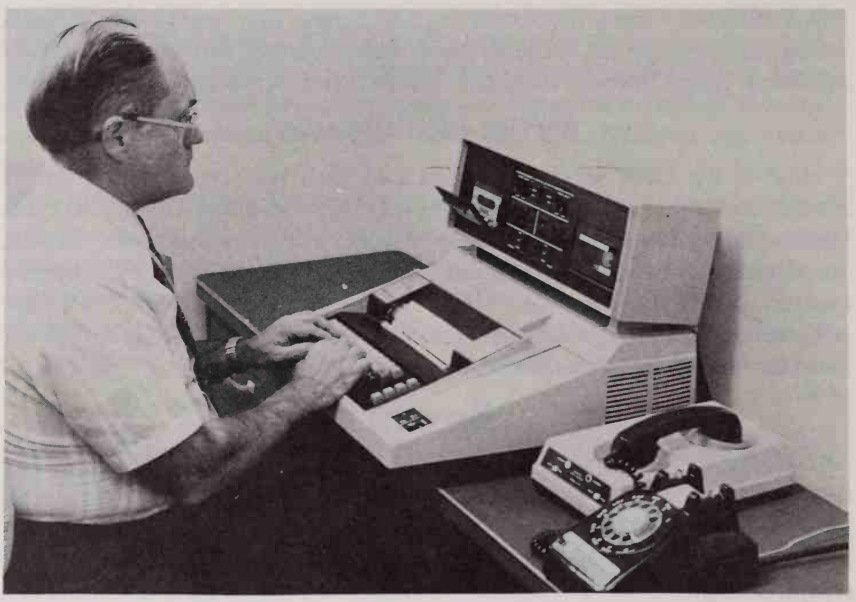
Three Ph.D. candidates (two from the University of Maryland and one from North Carolina State University) are using the herbarium facilities to complete their dissertations.

Selected Achievements

1969 Identified deadly poisonous *Abrus precatorius* seeds in jewelry, causing U.S. Food and Drug Administration to stop importation, interstate movement, and sale of these seeds

1973 Identified isolated seeds using conversational computer

1975 Made service identifications of papaveraceous seed fruits using conversational computer



PN-5487

FIGURE 2.—Curator using laboratory terminal connected by accoustical coupler to telephone, which transmits data to conversational computer in Washington, D.C.

1977 Circumscribed alfalfa (*Medicago sativa*) subspecies by legume-flower characters

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INDEX OF ACTIVE SYSTEMATISTS

Page

Anderson, Donald M. (immature Coleoptera) 29
Baker, Edward W. (Acari) 29
Batra, Lekh R. (Hemiascomycetes, Discomycetes) 15
Batra, Suzanne W. T. (Apoidea) 30
Blake, Doris H. (Chrysomelidae) 30
Burks, Barnard D. (Chalcidoidea) 30
Burns, John M. (Hesperioidea) 30
Carlson, Robert W. (Ichneumonidae) 30
Cartwright, Oscar L. (Scarabaeidae) 30
Clarke, Jack F. Gates (Microlepidoptera) 30
Crabill, Ralph E., Jr. (Chilopoda) 30
Cross, William H. (cotton insects) 27
Davis, Donald R. (Zeugloptera,
Dacnonypha, Monotrysia, Tineoidea) 30
Dewey, Douglas R. (Triticeae) 69
Duckworth, W. Donald (Stenomidae, Sesiidae) 30
Dudley, Theodore R. (vascular plants) 73
Duke, James A. (vascular plants) 81
Ellis, John J. (Phycomycetes, Ascomycetes,
Basidiomycetes, Deuteromycetes) 7
Emerson, K. C. (Mallophaga, Anoplura) 30
Erwin, Terry L. (Carabidae) 30
Farr, David F. (Basidiomycetes) 15
Farr, Marie L. (Myxomycetes) 15
Fennell, Dorothy I. (Ascomycetes, Deuteromycetes) 7
Ferguson, Douglas C. (Arctiidae, Geometridae, Lymantriidae) 31
Field, William D. (Pieridae, Nymphalidae, Lycaenidae) 31
Flint, Oliver S., Jr. (Trichoptera, Megaloptera) 31
Foote, Richard H. (Tephritidae, Pyrgotidae, Psilidae) 31
Friedman, William (nematodes) 61
Froeschner, Richard C. (Hemiptera-Heteroptera) 31
Fryxell, Paul A. (Malvaceae) 65
Gagné, Raymond J. (Cecidomyiidae, Mycetophilidae) 31
Golden, A. Morgan (nematodes) 61
Gordh, Gordon (Chalcidoidea) 31
Gordon, Robert D. (Scarabaeidae, Coccinellidae) 31
Gunn, Charles R. (seed, Fabaceae) 79
Gurney, Ashley B. (New World cockroaches and grasshoppers) 31
Hanneman, R. E., Jr. (tuber-bearing *Solanum* spp.) 67
Herring, Jon L. (Heteroptera) 31
Hewitt, George B. (grasshoppers) 59
Hodges, Ronald W. (Gelechioidea, Sphingidae) 32
Huang, Yiau-Min (Culicidae) 32
Hurd, Paul D., Jr. (Apoidea) 32
Jefferson, Roland M. (*Malus, Prunus*) 73

Page
Kingsolver, John M. (Bruchidae) 32
Knutson, Lloyd (Empididae) 32
Kramer, James P. (Cicadellidae, Fulgoroidea) 32
Krombein, Karl V. (aculeate Hymenoptera) 32
Kurtzman, Cletus P. (yeasts) 7
Lentz, Paul L. (Basidiomycetes) 15
Lichtenfels, J. Ralph (animal parasites) 3
McKnight, Kent H. (Basidiomycetes) 15
Marsh, Paul M. (Braconidae) 32
Mathis, Wayne N. (Drosophiloidea) 32
Mazzeo, Peter M. (vascular plants) 73
Menke, Arnold S. (aculeate Hymenoptera) 32
Meyer, Frederick G. (vascular plants) 73
Miller, Douglass R. (Coccoidea) 32
Muesebeck, C. F. W. (Proctotrupoidea) 33
Nakahara, Sueo (Coccoidea, Thysanoptera) 33
Nakamura, Lawrence K. (bacteria) 7
Nickle, William. R. (nematodes) 61
O'Neill, Kellie (Thysanoptera) 33
Parker, Frank D. (pollinating insects) 55
Peyton, E. L. (Culicidae) 33
Pollack, Flora G. (Deuteromycetes) 15
Pridham, Thomas G. (Actinomycetales) 7
Ross, R. W. (tuber-bearing *Solanum* spp.) 67
Russell, Louise M. (Aphidoidea, Aleyrodidae, Psyllidae) 33
Sabrosky, Curtis W. (Chloropidae, Tachinidae) 33
Sirivanakarn, Sunthorn (Culicidae) 33
Smiley, Robert L. (Acari) 33
Smith, David R. (Symphyta) 33
Spangler, Paul J. (aquatic Coleoptera) 33
Spilman, Theodore J. (Tenebrionidae) 33
Steyskal, George (Agromyzidae, Anthomyiidae) 33
Stoetzel, Manya B. (Aphidoidea, Aleyrodidae, Psyllidae) 34
Terrell, Edward E. (nomenclature, Poaceae) 81
Thompson, F. Christian (Syrphidae) 34
Todd, Edward L. (Noctuoidea) 34
Traub, Robert (Siphonaptera) 34
Uecker, Francis A. (Pyrenomycetes) 15
Weisman, Donald L. (immature Lepidoptera) 34
White, Richard E. (Anobiidae, Chrysomelidae) 34
Whitehead, Donald R. (Carabidae, Curculionidae) 34
Wirth, Willis W. (aquatic Diptera) 34